



INTEGRATING THE CAPABILITY MATURITY MODEL  
FOR SOFTWARE AND THE QUALITY AIR FORCE CRITERIA

THESIS

Marshall B. Messamore, Captain, USAF

AFIT/GCS/ENG/96D-19

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Air University

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Master of Systems

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*Abstract*

As defense budgets decrease and it is required to do more with less, the Air Force has chosen to use the Malcolm Baldrige National Quality Award (MBNQA) as the basis for implementing quality principles. The Air Force program is known as Quality Air Force (QAF), and the criteria are referred to as the QAF criteria [DEPA95b]. At about the same time the Department of the Air Force implemented QAF, the software leaders in the Air Force adopted the Capability Maturity Model for Software (CMM) as the internal standard for Air Force software organizations [MOSE91]. Software organizations strapped with both sets of requirements struggle with how to implement both models. Many organizations implement redundant programs in an effort to satisfy both. This research uses signature and specification matching techniques gleaned from the software reuse domain to integrate the CMM and QAF criteria into a single set of requirements that correlate to both models.

# INTEGRATING THE CAPABILITY MATURITY MODEL FOR SOFTWARE AND THE QUALITY AIR FORCE CRITERIA

## *I. Introduction*

### *1.1 Background*

In his 1993 book, *Decline and Fall of the American Programmer*, Ed Yourdon predicts the American programmer will “share the fate of the dodo bird” by the end of the decade [YOUR93]. Yourdon goes on to assert that international competition will be the downfall of American software companies based on three key organizational issues: cost of the staff, productivity of the staff, and quality of the systems developed [YOUR93]. To avoid Yourdon’s predictions of doom, many American software companies have turned to the concepts of Total Quality Management (TQM) as the basis for addressing two of the three key issues--increasing productivity of the staff and improving quality of the systems developed.

The application of TQM principles comes in many forms, such as the Malcolm Baldrige National Quality Award (MBNQA), the Capability Maturity Model for Software (CMM), and the International Standards Organization (ISO) 9000 standards to name a

few. The various forms of TQM have many commonalities, but often differ in scope, depth, breadth, and applicability; therefore, many organizations use a combination of two or more approaches in their quality programs [FALL93]. To combine multiple approaches can be quite difficult; it is essential to comprehensively understand each of the approaches used, and how the approaches interact.

Air Force software organizations have found out just how difficult it can be. The Air Force adopted the MBNQA criteria as its approach to implementing TQM principles. The criteria are the cornerstone of the Air Force quality program known as Quality Air Force (QAF). All Air Force organizations, including software organizations, are required to implement assessment and improvement programs based on QAF criteria [DEPA95a]. Air Force software organizations have an additional requirement. In addition to assessments and improvements based on the QAF criteria, software organizations must also implement assessments and improvements based on the CMM [MOSE91].

Multiple assessments and improvement efforts can be very expensive, especially in terms of time and human resources. The assessments for either model involve a great deal of training, planning, and preparation. Both types of assessment include multiple interviews with a significant number of members in the organization. In fact, for the QAF assessment at the Air Force Test and Evaluation Center, nearly one fifth of its 800 employees were interviewed in the validation phase, which is only one portion of the assessment process [REED94]. CMM assessments are no different. Current guidance on CMM-based assessments describes the typical assessment as involving a team leader, along with eight team members, interviewing four project leaders and 40 functional area

representatives, and expending about 200 person-days of effort [DUNA96]. Moreover, the assessment is only a small part of the overall cost of improvement programs. The Software Engineering Institute recommends investing one to three percent of development costs in CMM improvement activities [NEXT92]. In regards to the QAF criteria, commanders are not only required to perform assessments, but furthermore required to provide enough resources to implement the criteria [DEPA95b].

### *1.2 Problem*

The QAF criteria and the CMM are meant to spur process improvements with the ultimate goal of increased productivity, quality, and customer satisfaction. Nevertheless, attempts to combine the two approaches often produce the opposite effects in many Air Force software organizations. These organizations have failed to integrate the CMM and the QAF criteria into a single, coherent improvement strategy. Consequently, as stated by Mara of the Air Force Standard Systems Groups, "Air Force software units spend valuable resources attempting to implement parallel improvement initiatives" [MARA96]--one based on the CMM and the other based on the QAF criteria. Inevitably, parallel initiatives result in redundant objectives, redundant assessments, and redundant infrastructures. The Software Management Division of the Air Force Communications Agency, the office of primary responsibility for assessing software maturity, receives frequent requests for a strategy to integrate the two improvement approaches. With redundancy in assessments and improvement programs, Air Force software organizations waste scarce resources.

**Problem Statement:**

Air Force software organizations are unable to integrate the CMM with the QAF criteria, leading to parallel improvement initiatives, and resulting in the wasted resources.

*1.3 Research Objectives*

The goal of this research is to demonstrate the use of signature and specification matching (as described in Section 3.4.1 and 3.4.2, respectively) to integrate the process requirements imposed by the Capability Maturity Model for Software and the Quality Air Force criteria. The following objectives support the achievement of this goal:

1. Specify the process requirements stipulated by the CMM.
2. Specify the process requirements stipulated by the QAF Criteria.
3. Integrate requirements from each model into one set of consistent requirements.
4. Demonstrate the use of signature matching to integrate requirements.
5. Demonstrate the use of specification matching to integrate requirements.
6. Demonstrate the use of the integrated set of requirements by applying it to an organization process description, specifically the Standard Systems Group's System Engineering Process (SEP).
7. Illustrate the consistency and compatibility of the models.

#### 1.4 Approach

The following approach is used to meet the stated objectives and attain the overall goal of the research:

1. *Decompose the CMM and QAF Criteria into low level process requirements* - Each model is structurally partitioned into categories of logically-related process and sub-process requirements. Taking advantage of this structure, the requirements are further decomposed until each requirement specifies only one output, or a small number of strongly-connected outputs. Decomposing the models to this point is essential to fully understand each requirement with an aim towards formal specification of each requirement, if needed. (Supports Objectives 1 and 2.)
2. *Log process requirements into a framework for process documentation* - The primary purpose of the framework is to communicate process requirements to the sponsoring organization, as well as other process experts. A secondary purpose is to manage the many requirements. (Supports Objectives 6 and 7.)
3. *Specify signatures of each process requirement* - Signatures are identified in conjunction with the decomposition in Step 1. It is the linchpin of this approach. (Supports Objectives 3 and 4.)
4. *Integrate the requirements using signature matching* - The signature of each individual requirement is compared to the signature of all other requirements (including those from the same model) to determine a candidate list of redundant requirements. Contextual information is re-introduced to determine if any of the candidates can be definitively identified as matches. (Supports Objective 4.)
5. *Specify appropriate requirements in the Z specification language* - For those requirements not discernible as matches or non-matches using signature matching and contextual information, specification matching is used as the final discriminator. The requirements are specified in Z and then compared using specification matching. Using English, the requirements can only be compared in a conceptual, or notional manner. A formal language, on the other hand, provides the power of mathematically comparing inputs, outputs, and behaviors. (Supports Objective 5.)

6. *Integrate the remaining requirements using specification matching* - The behavioral specification for each requirement compared to other remaining requirements to definitively establish the relationship between the two. An exact match indicates redundancy, thus one of the requirements is eliminated. (Supports Objective 5.)
7. *Verify the integrated set of requirements* - Each requirement in the integrated set of requirements is correlated back to the model from which it originated. The set is checked for completeness by composing requirements (i.e., the processes they represent) from the final set into process descriptions. This step also provides information on the compatibility of the two models. (Supports Objective 3 and 7.)
8. *Apply the integrated set of requirements to a part of the sponsor's organizational process description* - A part of the Standard System Group's (SSG) Systems Engineering Process (SEP) is evaluated against the integrated set of requirements. Unmet requirements are identified and noted for the sponsor. The application step also acts as a validation for the integrated requirements. The process description is reviewed to identify processes or sub-processes with no corresponding requirement. The models are checked to determine if a requirement was lost in the approach or not provided. (Supports Objective 6.)

## *1.5 Assumptions*

*1.5.1 Pre-condition and Post-condition.* The first assumption is that both the CMM and QAF criteria may be specified in a pre-condition, post-condition form. While the CMM is largely structured in this form, the QAF criteria are not and may be much more difficult to specify in this form. This assumption is crucial to comparing requirements using specification matching.

*1.5.2 No Conflicts between the Models.* Secondly, assume there are no outright conflicts between the models, e.g., the CMM requires A and the QAF criteria requires  $\neg A$ . This is a reasonable assumption since both models support the same principles and

are used together by many organizations. If such conflicts do occur, the organization must simply make a decision on which method benefits it most.

*1.5.3 Key Processes Versus All Processes.* Neither model describes every process an organization needs or uses. The QAF criteria, although described as a “comprehensive set of results-oriented requirements” [DEPA95c], primarily discusses *meta-processes*, or processes to manage processes. The criteria do not attempt to describe each organization’s *production processes*. The CMM describes a software *production process*, along with *meta-processes*, but does not specify every process needed by an organization. For instance, the CMM barely addresses any human resource issues or processes outside of training.

Basically, both models are descriptive in nature; they describe what is to be done, but not how. In many cases, how a process is implemented involves many other processes not identified by either model. An example is data collection. Both models require data collection and give guidance on the type of data to collect, but neither describes the process to actually collect, store, or retrieve the data. This approach does not attempt to extend beyond the scope or depth already contained in the CMM and QAF criteria.

*1.5.4 Goals in the CMM Are Accomplished by Activities Performed.* The structure of the CMM contains goals for each *Key Process Area*. This approach assumes that performing all the practices in the *Activities Performed* and *Other Common Features* satisfies the goals. The goals are not explicitly addressed as process requirements.

## *1.6 Scope*

This research addresses how to integrate two sets of requirements, namely the CMM and QAF Criteria, based on signature matching and specification matching. It does not include how to conduct assessments based on either model, nor how to implement the requirements of either model. Neither does it address the applicability, nor the effectiveness of using either model in the Air Force. Likewise, this research does not advocate the use of one model over the other, but rather views them as complementary. Finally, this research does not include a method for converting scores from one assessment method to the other.

## *1.7 Overview*

The remainder of this document details the research outlined above. Chapter II discusses the literature reviewed in support of the research. It consists of sections on requirements analysis, process, software reuse, and the two models used in the research. Chapter III describes the approach followed in the research. It is divided into sections for each of the major steps in the approach. Chapter IV analyzes the approach and gives intermediate and final results. Chapter V addresses verifying results and applying them to a process description. The final chapter, Chapter VI discusses conclusions drawn from the research effort, how the approach can be used in other areas, and suggests some avenues for further research.

## *II. Literature Review*

### *2.1 Introduction*

The overall goal of this research is to demonstrate the use of signature matching and specification matching to integrate process requirements imposed by the Capability Maturity Model for Software and the Quality Air Force criteria. Several areas are reviewed to support this research. Section 2.2 contains a general discussion of requirements analysis, and includes formal methods, with an introduction to the Z language. The next section covers process; it consists of discussions on the software process, process modeling, and process improvement. Following that, Section 2.4 briefly discusses the current state of software reuse, along with two related methods for retrieving reusable components. Finally, Sections 2.5 and 2.6 preview the QAF Criteria and the CMM, respectively.

### *2.2 Requirements Analysis*

The purpose of the requirements phase of the software lifecycle is to sufficiently describe the behavior of the system by specifying the requirements the software system must meet. The requirements are meant to describe *what* the system does, without detailing *how* the system will do it [DAVI90]. The *what* versus *how* is often a matter of perspective, but a commonly accepted view for software is the *what* describes the problem domain and restricts the solution space. The *how* begins the design phase which chooses a particular solution to implement. The design phase begins with a description of

architectural components, major functions, and relationships, which are successively refined into the detailed design and code for the system [RUMB91].

Describing the problem domain involves activities such as interviewing, brainstorming, flowcharting, diagramming, and modeling. The objective is to fully understand the problem at hand and identify any constraints on the solution. Managing the data and information gathered and created is a key challenge to this part of the analysis phase. How well the data and information are managed has a direct bearing on the success of the next part of the analysis phase. In this part, there is a shift from the problem domain to the solution space, i.e., the *what* of the product is described. The goal is to completely specify the behavior of possible systems which solve the problem. Concisely documenting system behavior, resolving conflicts, and eliminating inconsistencies are the key challenges to this part of the analysis phase [DAVI90]. The analysis phase culminates in a requirements document.

*2.2.1 Informal Methods.* There are a variety of methods and methodologies to describe the *what* and the *how* of the software system. Informal methods are the most common. Informal methods include the use of natural language, flowcharts, data flow diagrams, entity-relationship diagrams, and control charts to name a few. Other informal methods such as Structured Analysis and Design Technique (SADT) and Object Modeling Technique (OMT) add structure and rigor to requirements analysis. Informal methods can be quite effective, but suffer from some limitations. One limitation is difficulty teaching the methods. Because informal methods often rely on art and experience rather than science and theory, it is hard to convey the knowledge to others.

Another limitation concerns automation. Automation, when used correctly, can significantly increase productivity and quality, but informal methods rely heavily on the human component, and are thus hard to automate. An additional limitation is the chance for error. Informal methods increase the possibility of misinterpreting or misstating requirements. More often than not, such errors promulgate through the design phase and into code. This is especially significant since it may be as much as 100 times more costly to fix an error in the maintenance phase than in the requirements phase [DAVI90, HART95].

*2.2.2 Formal Methods.* In an attempt to alleviate some of the limitations of informal analysis methods, formal methods were developed. Formal methods, unlike the informal ones mentioned above, are based in mathematics. The mathematics are typically expressed in the form of a formal specification language. Specification languages may be classified as property-oriented or model-oriented. Property-oriented specification languages indirectly describe system behavior in the form of axioms the system must satisfy. Model-oriented specification languages directly describe system behavior in the form of functions, relations, tuples, sets and sequences. Some examples of property-oriented specification languages are Larch, Anna, and OBJ. Some examples of model-oriented specification languages are VDM, state machines, and Z [MARC94].

*2.2.3 Z Specification Language.* Z is a model-oriented specification language, but it is also used for property-oriented specifications. Z specifications consist of a formal notation based on logic and set theory and an informal part written in natural language. Natural language is used for explanation and serves as a bridge between the real world

and the mathematics of the formal notation. The formal notation is organized by means of a *schema*. A schema is a collection of objects and axioms relating the objects to each other. Schemas may be combined through the use of schema calculus, providing a wealth of expressive power [MARC94, POTT91, SPIV88].

### 2.3 Process

This section provides an overview of process, specifically the software process and how it relates to the business process. It also surveys methods for understanding and improving the software process.

*2.3.1 Software Process.* The CMM defines the software process as a “set of activities, methods, practices, and transformations that people use to develop and maintain software and the associated products” [PAUL93b]. This definition does not mention the management infrastructure and support processes necessary to successfully develop software products. The management and support structures are often referred to as the business process. The business process has been the subject of great interest in recent years, as evidenced by the number of papers, books, and World Wide Web sites addressing business process engineering and re-engineering. The business process is also of interest to the software community, especially how it relates to the software process.

The software community has begun to appreciate the many similarities between the software process and business process [BOYD94]. In a panel discussion titled “Are Software Processes Business Processes Too?” at the *Third International Conference on the Software Process*, Henderson proposes a simple view of the relationship. He views

the software process as simply a special case of the business process. He defines the business process as "what the business does to make a profit" [HEND94]. In the case of a business that produces software to make a profit, the software process is a business process. Others on the panel, including Boyd [BOYD94], Scacchi [SCAC94], and Thomas [THOM94], share similar views to that of Henderson, namely that the software process and business process are closely related and tightly coupled to one another. Regardless of the particular viewpoint of how they are related, most would agree the critical process issues in both the software and business arenas are to define the process, manage it, and improve it. Processes to perform these functions are called meta-processes [DOWS94].

*2.3.2 Process Modeling.* To effectively manage and improve processes, organizations must first understand those processes [HUMP89]. An effective method for understanding a process is process modeling. Process modeling not only contributes to understanding processes currently in use in an organization, but also facilitates understanding what constitutes good, effective processes in general [DOWS94].

The notion of process modeling stems from Osterweil's 1987 paper "Software Processes are Software Too," presented at the 9th International Conference on Software Engineering [OSTE87]. In this seminal work in the process field, Osterweil makes a strong case for considering software processes the same as a software programs, i.e., using the same "techniques and formalisms" to describe them. He introduces the idea of *process programming*, or rigorously describing the software process much in the same way a software program is rigorously described using a programming language

[OSTE87]. Process programming is more commonly known today as process definition or process modeling.

There are several taxonomies for process models and associated techniques. Process models may be descriptive or active. Descriptive models describe what steps or activities must be accomplished, but do not address how they are accomplished. Active models, often called process enactment systems, prescribe actions, how to do them, and usually aid the software developer in accomplishing the task [SNOW96]. Another delineation between modeling techniques is static versus dynamic. Static models textually or graphically describe a process, while dynamic models are executable in some way. Static models are useful for understanding processes at a high level, but often do not provide the deeper understanding obtained by using dynamic models [BARG94]. These taxonomies may be used together to further characterize process models. A descriptive model may be static or dynamic, and an active model may be static or dynamic. Most active models are dynamic, as with Computer Aided Software Engineering (CASE) tools.

The selection of which technique or type of model to use depends on the goals of the modeling effort. Descriptive models are frequently used for determining how a particular process behaves under various conditions. For this purpose, the model is normally executable, or dynamic. Thus, the modeler is able to make experimental changes to the input conditions or the process model itself to identify opportunities for improvement. As mentioned above, active models are often used to enact, or help perform, the process. These active models must include specific information on the structure of the process, agents in the process, and artifacts produced or consumed by the process. Because of the

amount of detail involved, these type models are often called process definitions [DOWS93].

*2.3.3 Process Improvement.* In the past decade, software organizations around the country and around the world have searched for the engine to pull them out of the software crisis. Many have hoped for a “silver bullet” in the form of a technological advance which would slay the software werewolf [BROO87]. Humphrey notes this is not only wrong thinking, but dangerous thinking. Technology is limited by the process it supports. Poor process management brought about by an insufficient knowledge of the process severely degrades productivity and quality [HUMP89]. Productivity and quality gains are realized by a firm understanding and improvement of the underlying process. In the late 1980s, the software industry started to adopt Humphrey’s emphasis on the process as the leverage point for improving productivity and quality [NASE94].

As mentioned above, the objective of defining the process is to understand and improve it, but process improvement is not the end itself. Process improvement efforts must be firmly linked to the business goals of the organization. Business goals provide a context for improvement efforts [BOYC95]. For example, a process improvement effort may support a goal to increase productivity by eliminating steps in a process or otherwise decreasing execution time. When aligned with business goals, process improvement can be quite successful as evidenced by Hughes Aircraft [HUMP91], Raytheon Equipment Division [DION90], and Oklahoma City Air Logistics Center [BUTL95].

## 2.4 Software Reuse

Software reuse is a major player in the software development field. By reusing code alone, an organization can increase productivity and quality. Productivity increases because portions of a system are already analyzed, designed, and developed. Quality increases because reused code is managed more tightly and tested with each new use [YOUR93]. Although the gains from code reuse may be significant, it is even more lucrative to extend reuse beyond code to requirements, designs, tests, plans, architectures, and processes [BASI94]. Yourdon points out that coding comprises only 10-15% of the resources for a typical project, yet most of the efforts in reuse have focused on reusing code. This narrow focus, however, has begun to widen [YOUR93].

Despite the potential pay back, reuse (including code reuse) is far from prolific in the software community due to several factors. The factors hindering the application of software reuse in most organizations can be categorized as managerial, psychological, or technical. First of all, management must be committed to reuse before it will be effective and productive. Like any other major organizational direction, commitment means a long-term investment in the resources, tools, and training necessary for it to work. Management must address internal issues such as measurement of reuse products and processes, as well as explore external issues such as legalities and marketing [ZAND95]. Psychological factors also inhibit reuse. These factors primarily affect the programmers who are responsible for implementing reuse. Programmers take pride in creating their own solutions to problems, and do not fully trust the solutions of others. Combine these with a lack of incentive for reuse and a lack of understanding of reuse and it makes the

programmer's choice to apply reuse a difficult one to make [YOUR93]. Although managerial and psychological factors are recognized as important, most of the research addresses the technical factors limiting reuse. Technical factors include creating, classifying, storing, retrieving, verifying, and modifying components of a library. The major impediment is efficiently retrieving a component that meets current needs. Despite the amount of research in this area, "current techniques to represent and manage software components are not sufficient," according to Jeng [JENG95]. Jeng and Cheng's approach relies on formal methods to specify components and mathematically determine matches with requirements [JENG95]. Zaremski and Wing propose a similar method to match signatures and specifications[ZARE95a, ZARE95b].

*2.4.1 Signature Matching.* Signature matching is a simple method for identifying and retrieving components from a reuse repository [ZARE95a]. Identification and retrieval must be done effectively and economically for reuse to be profitable. Signature matching provides the economical means of identifying and retrieving candidate components from a repository based on match predicate and query. Zaremski and Wing define the general form of signature matching as [ZARE95a]:

$$\text{Signature Match}(q, M, C) = \{c \in C : M(c, q)\}$$

This says given a query  $q$ , a match predicate  $M$ , and a library of components  $C$ , *Signature Match* returns a set of components such that each component  $c$  is in the library and matches the query  $q$  based on the predicate  $M$ , i.e.,  $c$  and  $q$  satisfy  $M$  [ZARE95a].

Signature matching can be applied to functions or modules. Modules are essentially a collection of functions which operate on an abstract data type. Signature matching on

functions is essentially type matching on inputs and outputs. The match predicates for functions can take on several forms including *Exact Match*, *Generalized Match*, and *Specialized Match* [ZARE95a]. *Exact Match* means query and component match exactly. For example, the signature of a component that concatenates two strings might look like:

$$\text{Catenate: } \text{string}, \text{string} \longrightarrow \text{string}$$

For *Exact Match* to find and return this component, the query would also have to be:

$$q_1 = \text{string}, \text{string} \longrightarrow \text{string}$$

*Generalized Match* finds library components that are generalized forms of the query. Re-using  $q_1$  as the query, *Generalized Match* would return components that require two inputs of the same type and return that type. The signature of such components is:

$$c_1: X, X \longrightarrow X$$

*Specialized Match* means the library component is a specialized form of the query. In this case,  $c_1$  becomes the query,  $q_2$ :

$$q_2 = X, X \longrightarrow X$$

This query would return *Catenate*, in addition to any other component with a signature of this form. For example, the following components would also be returned:

$$\text{AddInt: } \text{int}, \text{int} \longrightarrow \text{int}$$

$$\text{MergeFiles: } \text{file}, \text{file} \longrightarrow \text{file}$$

Signature matching on modules involves matching types for the set of user-defined types used in the module, along with matching the function types for all functions in the module. *Exact Match* is as expected; all user-defined types must match, as well as all

function types for each function in the component and each function in the query. The mapping of functions in the query to functions in the component is *one-to-one* and *onto*. *One-to-one* means that for each function in the query there is only one function in the component that matches it. *Onto* means all the functions in the component are matched to functions in the query. *Partial Match* entails using queries that specify only a subset of the functions contained in the library module. The mapping from query function to component function does not need to be *onto* [ZARE95a].

**2.4.2 Specification Matching.** Specification matching is essentially the same concept as signature matching. The purpose is to identify and retrieve components from a reuse repository. The difference is the depth at which components are matched. In signature matching only the input/output types are compared to determine a match. This technique provides a good filter for identifying candidate components, but may lead to some surprises. To illustrate this point, consider the signature of two possible string operations, *Catenate* and *Replace*:

*Catenate: string, string  $\longrightarrow$  string*

*Replace: string, string  $\longrightarrow$  string*

The two have the same signature and would match the same queries; however, the two behave very differently. For this reason, specification matching must be used as a tighter filter to identify reuse components.

Specification matching at a simple level is merely a logical equivalence or logical implication between the query specification and the component specification [ROLL90].

At a deeper level, matching can be divided into *Pre/Post Matches* and *Predicate Matches*. *Pre/Post Matches* are comparisons of the query pre-conditions against the component pre-conditions and the query post-conditions against the component post-conditions. There are a variety of matches depending on the nature--implication or equivalence--and the direction of comparison. The *Predicate Match* addresses all predicates in the specification of the query and component. Again there is a variety mirroring those of the *Pre/Post Matches* [ZARE95b].

## 2.5 *Quality Air Force Criteria*

2.5.1 *QAF History*. As defense budgets decrease and it is required to do more with less, the Department of Defense (DOD) has chosen to use Total Quality Management (TQM) as the means for increasing productivity, quality, and customer satisfaction. One well-known method for implementing TQM is the Malcolm Baldrige National Quality Award (MBNQA). The MBNQA, established in 1987 and named after then-Secretary of Commerce Malcolm Baldrige, has a strong reputation as a quality award. It is awarded annually to companies that exemplify the quality ideals and concepts embodied in the criteria [KAN95]. Because of this strong reputation, the Air Force arm of the DOD has chosen the MBNQA as the basis for implementing TQM in Air Force organizations. The Air Force program is known as Quality Air Force (QAF), and the criteria are referred to as the QAF criteria [DEPA95b].

2.5.2 *Overview of the QAF Criteria*. The criteria are built upon four basic elements as seen in Figure 1 [DEPA95c]. The *driver* is organizational leadership. Organizational leadership drives the *planning process* in a comprehensive approach to setting goals and

making plans based on customer requirements. Progress toward goals is determined by *measures of progress* also used to manage the system. Ultimately, the *goal* is to increase value to the customer [DEPA95a, DEPA95c, FALL93].

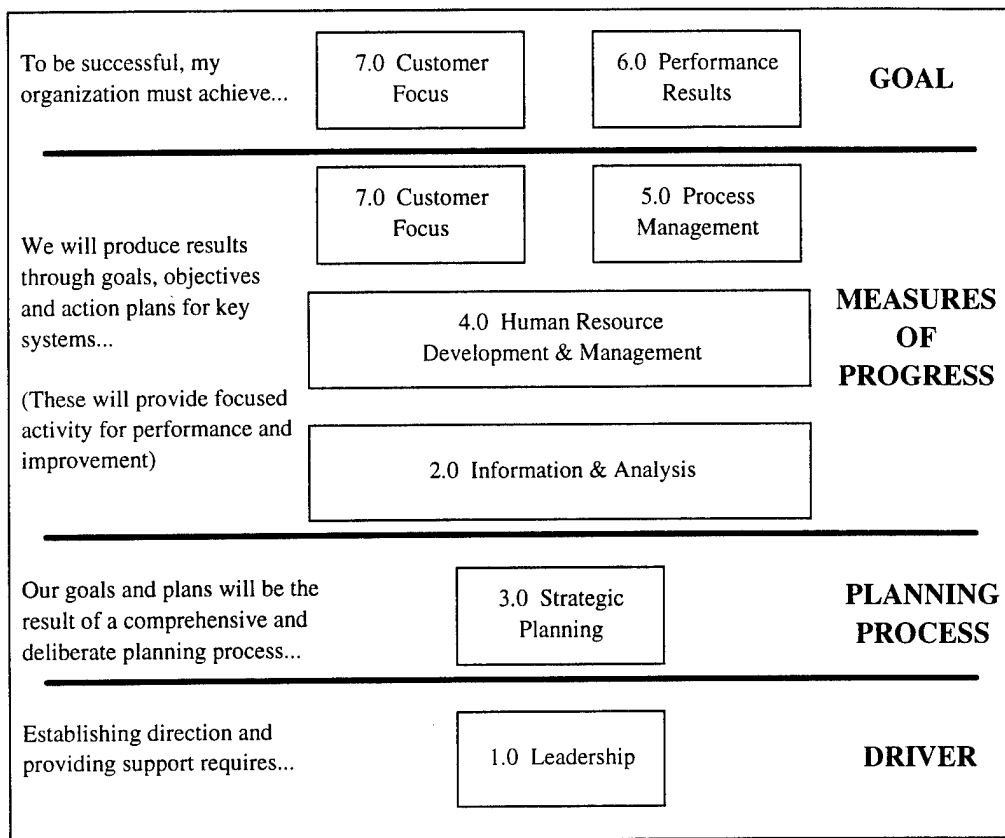


Figure 1 Quality Air Force Criteria. [DEPA95c]

These four elements provide the basis for assessing a “unit’s leadership and management, as shown in mission and functional area performance, installation support, people programs, service to customers, and conformance” to customer requirements [DEPA95a].

**2.5.3 QAF Criteria Structure.** The QAF criteria are functionally structured into seven inter-related *Categories* to aid assessment. The categories are sub-divided into 24 *Examination Items*, which are further divided into 54 *Areas to Address*. Each

examination item is scored on three dimensions: *approach*, *deployment*, and *results*. The *approach* is how the organization addresses the requirement. The *deployment* is the extent to which all areas of the requirement are addressed, and *results* “refer to the outcomes in achieving the purposes given in the item” [DEPA95c]. All Air Force units are required to conduct QAF assessments (QAFA) [DEPA95a]. The next section provides short descriptions of each of the seven categories.

#### *2.5.4 QAF Categories.*

*2.5.4.1 Leadership.* This category provides the focus within the criteria for the organizational leadership and strategic direction. Leadership is the driver for moving the organization. The category addresses the entire management infrastructure and how it translates mission objectives into performance results [DEPA95c].

*2.5.4.2 Information and Analysis.* This category covers the management of the key information required to assess and improve the organization’s overall performance. The processes in this category provide the mechanism for senior leadership to align organizational processes with strategic directions. Furthermore, this category provides the foundation for all measures of progress [DEPA95c].

*2.5.4.3 Strategic Planning.* Strategic planning involves setting a vision for the organization based on customer needs and operational performance requirements, and translating that vision into a coherent plan for achieving quality, increasing customer satisfaction, and improving business performance. Key issues in this category are effective deployment of plans, continuous improvement of processes, and optimization of resources [DEPA95c].

*2.5.4.4 Human Resource Development and Management.* This category is the focal point in the criteria for all human resource issues such as training, morale, and quality of life. The purpose of the category is to ensure human resources are effectively managed to create a high performance workplace that supports the strategic direction of the organization [DEPA95c].

*2.5.4.5 Process Management.* Process management emphasizes the importance of managing the processes essential to providing products and services to meet customer needs. This includes production line processes, as well as support processes. Proper process management is a principal part of the capability to accomplish strategic goals [DEPA95c].

*2.5.4.6 Performance Results.* In short, this category is a measure of how well an organization meets its goals. Data is collected based on product and service quality, operational performance, customer satisfaction, and mission effectiveness indicators to provide “real-time information for evaluation and improvement of processes.” [DEPA95c].

*2.5.4.7 Customer Focus and Satisfaction.* This category captures the essence of the QAF criteria. It is both a goal and a measure of progress. As a goal, customer focus is the foundation for determining organizational priorities and planning improvement activities. As a measure of progress, customer satisfaction helps the organization determine development toward the customer focus goals [DEPA95c].

## 2.6 Capability Maturity Model for Software

**2.6.1 CMM History.** At about the same time the DOD was adopting TQM, the Air Force was searching for a method to assess the software capability of its contractors. The Air Force turned to the Software Engineering Institute (SEI) for help. Watts Humphrey of the SEI applied the quality principles of W. Edwards Deming, Joseph Juran, and Philip Crosby to the software field and developed an initial framework for assessing process capability. Using knowledge gained from using the framework and associated questionnaire, along with comprehensive feedback from government and industry, the SEI extended the framework into an extensive model of organizational practices in 1991. The model was updated in 1993 based on additional feedback from government and industry. The current version of the CMM is contained in CMU/SEI-93-TR-24 [PAUL93a]. The key practices are listed in CMU/SEI-93-TR-25 [PAUL93b].

**2.6.2 CMM Structure.** The CMM is functionally structured into 18 *Key Process Areas (KPAs)*. *KPAs* are divided into five subcategories called *Common Features*. The *Activities Performed Common Feature* describes the activities an organization should perform in the respective *KPA*. The other *Common Features* relate to institutionalizing the activities described [PAUL93b]. The following section previews the CMM.

**2.6.3 CMM Overview.** The primary purpose of the CMM is to help software organizations gain control of their software process, changing their culture to one of software engineering excellence, and ultimately decreasing risk while increasing productivity and quality. To fulfill this purpose, the CMM is structured in a manner that facilitates an evolutionary approach to improving processes [PAUL93a]. It is divided

into levels which characterize the process maturity of an organization as it progresses toward continuous improvement. Figure 2 captures the essence of the CMM by depicting each *Maturity Level* along with the focus and key process areas which describe that level [PAUL93a].

## Capability Maturity Model (CMM)

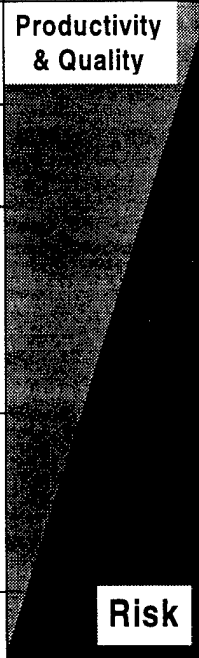
Level	Focus	Key Process Areas	Result
<b>5 Optimizing</b>	Continuous Process Improvement	Defect prevention Technology innovation Process change management	Productivity & Quality
<b>4 Managed</b>	Product and Process Quality	Quantitative Process Mgt Software Quality Management	
<b>3 Defined</b>	Engineering Process	Organization process focus Organization process defn. Peer reviews Training program Intergroup coordination Software product engineering Integrated software mgt.	
<b>2 Repeatable</b>	Project Management	Software project planning Software project tracking Software subcontract mgt. Software quality assurance Software configuration mgt. Requirements mgt.	
<b>1 Initial</b>	Heroes		

Figure 2 Capability Maturity Model (CMM) for Software. [PAUL93a].

Each maturity level represents a plateau in an organization's progression toward continuous improvement. The *Focus* column lists the issues which characterize an organization at that maturity level. The *Key Process Areas* are the critical competencies the organization must have mastered to have reached that maturity level. The *Result* column depicts the payoff for an organization moving up the maturity model--as risk decreases, productivity and quality increase.

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### *III. Approach*

#### *3.1 Introduction*

As stated in Section 1.3, the overall goal of this research is to demonstrate the use of signature matching and specification matching to integrate the process requirements imposed by the CMM and the QAF criteria. To accomplish this goal, the CMM and QAF criteria are viewed as sets of process requirements for organizations to fulfill. Based on Osterweil's conception of software process as software [OSTE87], the *process requirements* are analyzed as *software requirements* using software analysis methods such as functional decomposition, object diagrams, and formal specification. Each set of requirements is analyzed, decomposed, and logged using a simple framework. The signatures are specified and matched using contextual information as a backdrop. Requirements requiring further examination are formally specified using the specification language Z, and the specifications compared. The final integrated set of requirements represents all process requirements enjoined by the two models; thus, it is applied against a real process description to identify unmet requirements in the process description, or omissions in the integrated set of requirements. The following paragraphs expound on this approach.

#### *3.2 Requirements View of Models*

The QAF criteria and the CMM are often used as references to set organizational goals and plan process improvements. Viewed from a slightly different perspective, these

two models provide a description of *what* an organization must do to achieve organizational goals and realize process improvements. This description is a requirements specification for the organizational system. The overviews of both models corroborate the requirements specification view. The QAF criteria are depicted as a non-prescriptive, yet comprehensive set of process requirements for organizations to fulfill [DEPA95c]. The CMM verbiage is less direct, using the word *criteria* instead of *requirements*. The CMM is described as a set of "criteria describing the characteristics of mature software organizations" [PAUL93a]. Hence, both models are considered as informal requirements documents.

The next issue concerns what to do with these requirements documents. The goal of this research is to integrate the two sets of requirements into one comprehensive, consistent set. However, in their current form, Air Force software organizations have difficulty integrating the models. One major difficulty relates to the scope of the models. The CMM is more project focused with a flavor of the organization level. By contrast, the QAF criteria is more organization focused with a flavor of the project level. The different scopes make them complementary in concept, but in practice the exact boundaries and interactions between the models are difficult to discern. Another difficulty relates to the language used by each model. The QAF criteria is meant for a broad range of organizational missions. The language is very general; it does not mention specific roles, documents, or organizational structures. Conversely, the CMM is meant for software organizations. It discusses roles such as the project software manager, documents such as the software development plan, and organizational structures such as

the software engineering group. Due to such differences, it is necessary to translate the models into a form more amenable to integration. The first step toward that objective involves analyzing and decomposing each model into the lowest level requirements.

### *3.3 Functionally Decompose Requirements*

The QAF criteria and the CMM are each structured along functional lines, as described in Section 2.5.3 and Section 2.6.2, respectively. The functional structures serve as backdrops for decomposing the models even further. The aim is to decompose the models until all requirements represent a process or activity with a single output or two to three tightly-coupled outputs. Decomposing to this level more readily allows comparisons between requirements. Another motivation for decomposing to this level relates to complexity. At this lowest level, the complexity resulting from the relationships and interfaces between multiple functional components is greatly mitigated. Each low-level requirement is more easily understood and managed.

Understanding the requirements is the key to building any complex system. The requirements analyst must have a solid grasp of the problem domain in order to constrain it sufficiently to derive the solution space. The analyst obtains the knowledge from the user's problem statement or requirements document. The analysis process produces a more concise description, while eliminating redundancy, inconsistency, and ambiguity [RUMB91]. Although the goal of this research is not to build a system, understanding the requirements is no less important. The CMM and QAF criteria are considered user requirements documents. Each document must be well-understood, and transformed into

a concise, consistent, unambiguous format. The result of this step is a restatement of requirements from both models in a simple, understandable format.

Managing the numerous requirements is another important aspect of this approach. This approach uses a framework as the means to manage the requirements. The framework includes the following fields: *Name, ID, Purpose, Agents, Correlates to, Inputs, Outputs, Entrance Criteria, Exit Criteria, and Comments*. In addition to being a management tool, the framework serves as an informal method of communicating the results of requirements analysis to the sponsor of the research. The idea of using this type of framework is taken from Hollenbach and Frakes [HOLL96]. Their framework is used to document and define processes, and place them in a process library for the purpose of reuse. Since this approach deals completely with process requirements, as opposed to actual processes, the framework used here is far less elaborate.

### *3.4 Integrate Requirements into One Set*

Integrating the two sets of requirements from the respective models into a single non-redundant, complete set of requirements is the crux of this problem. The primary vehicle for eliminating redundancy in this approach is *signature matching*. Signature matching involves comparing the signatures, or interfaces, to identify potentially similar components. The signature of a requirement is specified by the types associated with the inputs and outputs of the process the requirement represents. The signature is the interface of the process. As the requirements are decomposed to the lowest level, the

types of the inputs and outputs are identified and recorded for use in signature matching, which is explained in the following section.

**3.4.1 Signature Matching.** Signature matching is paramount to this research. Recall that signature matching entails comparing the interfaces, or input/output types of functions or modules. (No concern is paid here to the order of types in the signature. The actual process of matching signatures is primarily accomplished using a spreadsheet, thus the order is easily transformed. Zaremski and Wing illustrate an automated proof system which must handle the transformation without human intervention [ZARE95a].) The general form of the signature match is:

$$\text{Signature Match}(q, M, C) = \{c \in C : M(c, q)\}$$

In this research, the process requirements from both models are considered to be functions that make up the component library  $C$ . A process requirement is drawn from  $C$  to act as the query  $q$ . (In theory, this specification may be drawn at random; however, in practice, the requirements are sorted by signatures and requirements likely to be redundant are chosen.) The match predicate  $M$  for this approach is *Exact Match* or *Partial Match*. The Z form of *Exact Signature Match* and *Partial Signature Match* for this approach follow in Figures 3 and 4:

<div style="border-left: 1px solid black; border-right: 1px solid black; padding: 0 10px;"> <div style="border-bottom: 1px solid black; margin-bottom: 10px;"> <math>\_esm\_ : Procreq \leftrightarrow Procreq</math> </div> <div> <math>P_1 \text{ esm } P_2 \Leftrightarrow</math>  <math>\quad ran\ P_1.inputs = ran\ P_2.inputs \wedge</math>  <math>\quad ran\ P_1.outputs = ran\ P_2.outputs</math> </div> </div>
---

Figure 3 Exact Signature Match.

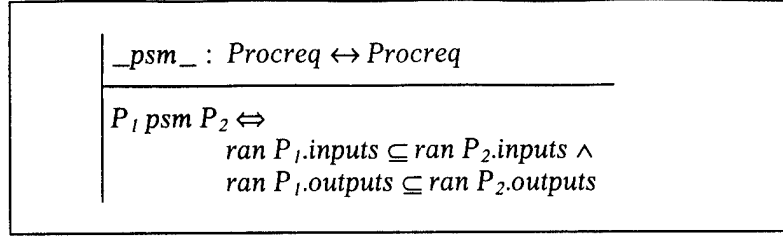


Figure 4 Partial Signature Match.

As an example, the signature of a process to measure a product might look like:

$$MeasureProduct: \{product\}, \{indicator\} \longrightarrow \{data\}$$

Another process to measure the quality of a product might be represented by the following signature:

$$MeasureQuality: \{product\} \longrightarrow \{data\}$$

In this situation, it is desired to identify these as potentially matching processes. *Exact Signature Match* would fail, but *Partial Signature Match* would identify these as potentially redundant requirements. In this simple case a decision can be made at this point to eliminate the less general of the two. In this example, *MeasureQuality* would be eliminated in favor of *MeasureProduct*, and any information in the *Correlates to* and *Comments* fields of *MeasureQuality* would be included in *MeasureProduct*. For this research, signature matches along with contextual information generally suffice to determine redundancies. However, in more complicated situations, *specification matching* is needed to determine if two specifications match under tighter constraints.

**3.4.2 Specification Matching.** Specification matching is used sparingly in this approach since most matches may be determined using signature matching outcomes and contextual information. Nonetheless, some situations warrant this level of comparison.

The objective of the step is to represent the process requirements in first order predicate logic. This can be done in Z.

*3.4.2.1 Formally Specify the Appropriate Requirements in Z.* The information in the informal framework is translated into the formal specification language Z. A formal language such as Z offers a more precise description of requirements without sacrificing brevity. In addition to precision, a formal language allows the use of mathematics as a means of eliminating ambiguity and demonstrating parts of the specification [POTT91].

Formal languages also facilitate abstraction during requirements analysis and specification. Abstraction plays a significant role in this approach. Both models refer to a number of entities such as people, data, products, processes, etc. Generally, the internal structure of an entity is unimportant to analyzing the process requirement in this approach. The set theory of Z allows the establishment of global sets representing these abstractions. For example, a global set *WORKFORCE* may be used to represent all the members of an organization. In this form, specifications are compared to determine if matches exist.

*3.4.2.2 Match Specifications.* The formally specified requirements are compared using specification matching as described by [ZARE95b]. The match predicates for specification matching are those associated with *Pre/Post Matches*. The internal behaviors of the processes are not of consequence, but rather the pre- and post-conditions. The Z forms of the Exact Specification Match and Partial Specification Match are given in Figures 5 and 6:

$\_espm\_ : Procreq \leftrightarrow Procreq$
$P_1 \text{ espm } P_2 \Leftrightarrow$ $P_1 \text{ esm } P_2$ $P_1.pre \Leftrightarrow P_2.pre$ $P_1.post \Leftrightarrow P_2.post$ $P_1.subproc = P_2.subproc$

Figure 5 Exact Specification Match

$\_pspm\_ : Procreq \leftrightarrow Procreq$
$P_1 \text{ pspm } P_2 \Leftrightarrow$ $P_1 \text{ psm } P_2$ $P_1.pre \Rightarrow P_2.pre$ $P_2.post \Rightarrow P_1.post$ $P_1.subproc \subseteq P_2.subproc$

Figure 6 Partial Specification Match

In the Partial Specification Match,  $P_1.pre \Rightarrow P_2.pre$ , but the order is reversed for the post-conditions, namely  $P_2.post \Rightarrow P_1.post$ . Consequently, if the relationship between pre-conditions and post-conditions is also  $pre \Rightarrow post$ , then it is guaranteed that  $P_1 \Rightarrow P_2$ . This indicates  $P_2$  is the more general of the two process requirements. Of course, in the Exact Signature Match the match predicate is equivalence and the order does not matter.

### 3.5 Verify Integrated Set

To verify the integrated set completely represents both models, each *Area to Address* from the QAF criteria and *Key Practice* from the CMM is correlated to the requirements that specify it. This ensures the models are adequately covered. Another means of verification is to compose requirements (i.e., the processes they represent) into process

descriptions which represent a functional area such as process management. Composing requirements in this manner also provides insight into the compatibility between the models.

### *3.6 Apply to Process Description*

The result of the integration step achieves the overall goal of this research--to demonstrate the use of signature and specification matching to integrate the process requirements imposed by the CMM and QAF criteria. However, an additional objective is to demonstrate the use of this set.

In the software lifecycle, the requirements phase culminates in a requirements document describing *what* the system does. The design phase initiates to determine *how* the system behaves to meet those requirements. In this research, the integrated set of process requirements, along with the associated framework documentation comprise the requirements document. Naturally this document is used to design processes to meet all the stated requirements.

The sponsor of this research (as well as many other Air Forces software organizations) already has a process design intended to meet these requirements. Thus, the requirements document is used as a validation tool to determine if the design of Standard Systems Group's systems engineering process (SEP) meets the design requirements. The validation is accomplished simply by tracing requirements identified by the requirements document to actual processes in the SEP. The absence of processes to fulfill requirements indicates inadequacies in the SEP design. Since the QAF criteria

and especially the CMM identify only key process requirements (see Section 1.5.3), some SEP processes may not trace back to the requirements document. The necessity of these processes must be determined by other requirements (which could also be integrated into the requirements document using this approach). Backwards tracing also acts as a partial verification of the requirements document by possibly illuminating missing requirements.

The requirements trace will be done on a limited basis to demonstrate the utility of the requirements document. If the processes in the SEP were formally specified (and given the appropriate tools), formal queries could be formed to trace process requirements to all occurrences in the design--in this case, the SEP.

#### *IV. Analysis and Results*

This chapter discusses analysis of the research approach, along with intermediate and final results. The first section examines the approach itself and its effectiveness. The next section covers issues related to the analysis and decomposition of the two models. Finally, the last section provides a look at the results of the approach at the intermediate steps, as well as at the end.

##### *4.1 Analysis of Approach*

*4.1.1 Functional Decomposition.* Functional decomposition is a valuable step in this approach. The purpose of decomposing the requirements is to reduce complexity of multiple inputs, outputs, and conditions on a process, and to gain deeper understanding of the given requirements. The deeper understanding provides contextual information necessary for making decisions on which requirement specification to keep when matching signatures and specifications.

However, the purpose of this step may be accomplished through other tools or methods. In particular, the ad hoc use of tools such as data flow, IDEF0, and entity-relationship diagrams may be helpful; however, to receive the maximum benefit from these tools, they must be planned for, and integrated into, the approach. In addition to better utilizing tools, different methods of analysis may also be beneficial. Although the CMM and QAF criteria are functionally designed, an object-oriented approach to analyzing these models may be better. The heart of this approach is matching the process

requirement signatures, which consist of the input/output types. These types normally translate into object or object classes in object-oriented analysis. Using object-oriented analysis, the focus is on input/output types, or objects, from the beginning of the approach, thus facilitating signature matching. Additionally, the processes (or process requirements) themselves may be viewed as objects. The object view eases the task of composing integrated processes back together into a coherent model of an entire organization or some piece of it, such as a division or project.

*4.1.2 Framework.* The framework has a twofold purpose. The primary purpose of the framework is as a communication device. In this role, the framework is very effective. It provides a standard template for presenting all the information on each requirement to the customer. The framework used in this approach is a greatly scaled-down version of Hollenbach and Frake's [HOLL96] since most requirements are simply for a process to exist. Hollenbach and Frake's framework is used to record more detailed information on processes, such as tools, procedures, and metrics. Nonetheless, with a large number of required processes, the framework can quickly get unwieldy.

The secondary purpose of the framework is as a tool for managing the requirements as they are gleaned from the models. As a requirements management tool for this approach, the framework adds little value. A spreadsheet is a much better alternative for managing the requirement during the decomposition and matching steps. With the spreadsheet, subsets of the information put into the framework are easily created, thus enhancing signature matching. However, as a tool for managing the requirements or

associated processes on a long-term basis, the framework is a good choice. Thus, for this approach, the framework is best produced near the end, after all the analysis is done.

*4.1.3 Use of Formal Language.* The use of a formal language in this approach is central to the signature and specification matching paradigms. However, in this particular application of integrating the CMM and QAF criteria, using a formal language does not add a great deal of value. The primary reason for this is the nature of the CMM and QAF criteria. Both models are descriptive, rather than prescriptive. They tell what to do, but do not specify how. As a result, the requirements derived from the models generally state a process must exist and be used by an organization, but seldom specify any behavioral aspects of the process. Some process behaviors are specified in the models, but these behaviors may be viewed as sub-processes instead of pre-conditions or post-conditions.

There is also a secondary reason that this particular application of the approach does not benefit significantly from a formal language. The secondary reason is lack of automation for the formal language. For this application, signature matching bears the bulk of the workload. Although Z's types and schemas are ideal for use in signature matching, it lacks an automated proof-checker and associated search engine. Consequently, Z brings little to the signature matching table. Most of the signature matching work is done more efficiently by a spreadsheet. Even specification matching is as easily done without the use of Z or another formal language.

*4.1.4 Modeling in Z.* Modeling the requirements in Z is a bit troublesome, although not directly due to the nature of Z. The troublesome question is whether to model the

process requirements as static objects or as operations. The difference may be seen by considering the Z schemas in Figures 7 and 8.

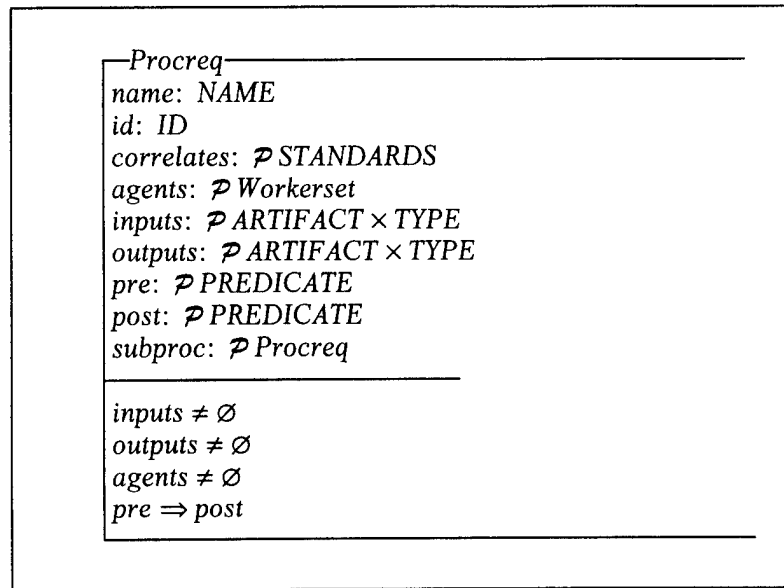


Figure 7 Process Requirement as a Static Object.

In Figure 7, the schema describes attributes of the object called *Procreq*. *Procreq* is merely a translation of a process requirement specified in the CMM or QAF criteria. The information related to the required process is provided in the signature using the components: *name*, *id*, *correlates*, *agents*, *inputs*, *outputs*, *pre*, *subproc*, and *post*. The predicate part of the schema states invariant constraints on all objects of this type.

The schema in Figure 8 specifies an actual process (in contrast to a process requirement) as an operation on the organization. Inputs and outputs are separate components, and pre-conditions and post-conditions are given in the predicate part of the schema. Sub-processes may also be listed in the predicate. When placed in the predicate

in this way, the sub-processes are mandatory parts of the current process. The schema, when instantiated with actual values, is the skeleton of an actual process specification. It can be used in the skeletal form as a query for more complete processes, or be expanded to serve as a process specification.

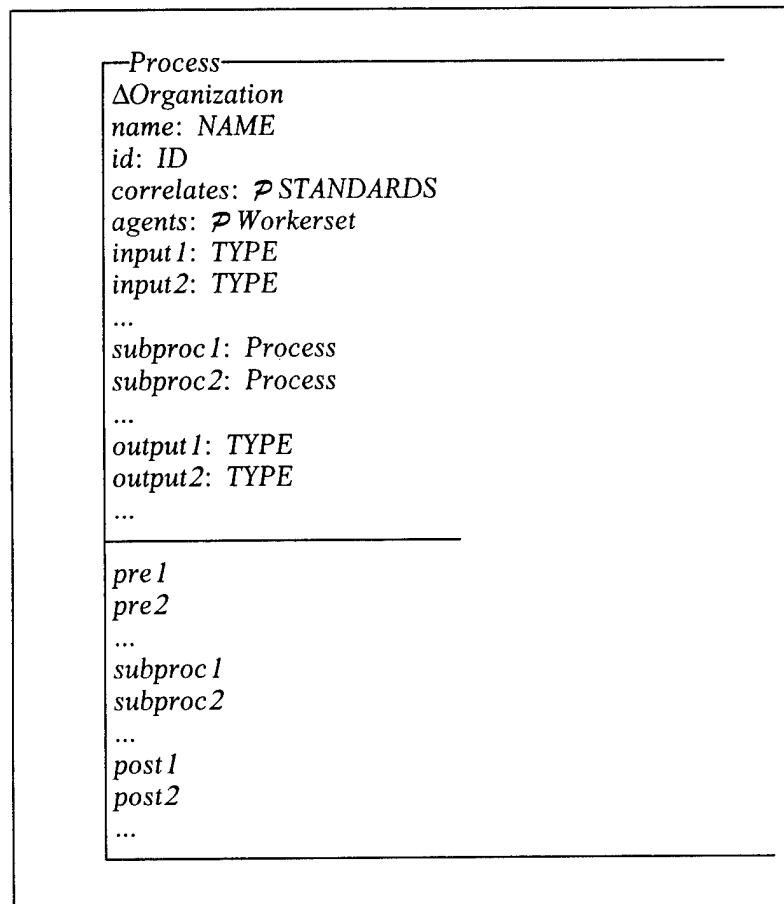


Figure 8 Process Requirement as Operation.

The question of whether to model the process requirements as objects or as operations is best answered based on the application of the approach. In this particular

application, process requirements are modeled as objects to be compatible with [HIBD95]. This issue is discussed in Section 6.3.1.1.

*4.1.5 Signature and Specification Matching.* Signature matching is the real workhorse of this approach. As mentioned in Section 3.2, merging the two models in their present form is quite difficult. The difficulty arises in large part from the semantics associated with the process requirements. Terms such as *key performance drivers* and *work organizations* from the QAF criteria, and *requirements allocated to software* and *project's defined software process* from the CMM are difficult to translate from one context to another because they hide their basic identity or type. However, signature matching focuses on the syntax of requirements. It uses the fundamental types of process artifacts, not the names of artifacts. In other words, the concept of signature matching provides a method for distilling out semantics and leaving syntax. Once matches are found, semantics are restored to provide context for determining a true match.

Although specification matching is integrated into this approach, for this application it is used sparingly. Comparisons based on matching signatures and context are sufficient to identify most redundant requirements. Specification matching is not needed as much due to the nature of the two models, as described above. The models mostly require the existence of the processes, but not much beyond that. Furthermore, process requirements are compared to other process requirements, not full-blown requirements specifications, which typically have more information to consider.

## 4.2 Analysis Issues

### 4.2.1 Comments on the Models.

4.2.1.1 *QAF Criteria.* The QAF criteria is certainly a comprehensive document, which embodies the tenets of the quality movement. However, it is not particularly well-written, nor well-structured at a low level. The structure of *Categories*, *Items*, and *Areas to Address* do not adequately partition the requirements. A single *Area to Address* may impose several process requirements. A case in point is the description of the very first *Area to Address*:

**Area 1.1.a.** calls for information on the major aspects of senior leadership - creating values and expectations, setting directions, developing and maintaining an effective leadership system, and building organization capabilities. Senior leaders need to reflect these values, and the leadership system needs to include teamwork at the headquarters level. [DEPA95c]

There are several process requirements embedded in these two sentences, including *Set Values*, *Set Expectations*, *Set Directions*, *Develop Leadership System*, and *Maintain Leadership System*. In addition to the descriptions, such as the one given above, the QAF criteria also include criteria and guidance for assessment. Instead of the descriptions and assessment criteria reflecting and complementing each other, the two often identify different requirements related to the same *Area to Address*. These often add further requirements for the organization to meet.

Another criticism is the lack of pictures or diagrams. The diagram shown in Section 2.5.2 is the only diagram (other than linkage diagrams) for understanding the criteria. This diagram is insufficient to explain the cyclic nature of the QAF system. Process flow

diagrams showing the interaction among the categories, such as the one provided by Brown in [BROW94], page 224, greatly increase understandability of the QAF system. The readability of linkage diagrams mentioned above could also be improved.

**4.2.1.2 CMM.** The CMM, by contrast, is a very readable document. The structure consisting of *Key Process Areas (KPA)*, *Goals*, *Common Features*, and *Key Practices* is explained up front and used throughout the document. The authors use a standard template to relay the information to the reader. When referencing other parts of the model, the CMM identifies the exact location for the reference. Although no diagrams appear in the practices, the pictures in the overview sufficiently convey the essence of the CMM. Moreover, the CMM explains peculiar terms and concepts very well in the overview and glossary sections.

#### **4.2.2 Analysis Decisions.**

**4.2.2.1 Relation of Inputs to Outputs.** All inputs are assumed to be non-empty, unless otherwise stated, and contribute to the outputs. Empty inputs may occur when a process requirement is specified at Maturity Levels 2 (ML2) and 3 (ML3) of the CMM. At ML3, the process is required to take as input the Project's Defined Software Process (PDSP), but at ML2 this formalized process does not yet exist. The input for the PDSP may be empty. See the requirement for *Project Planning* in Appendix A, page A-42 for an example. The assumption that all inputs contribute to producing outputs is particularly relevant to process requirements that specify that X is the basis for A. An example of this situation is found in the QAF criteria Area 1.2.b where it specifies that "...stated values

and expectations are actually the basis for organization actions and key decisions” [DEPA95c].

**4.2.2.2 Meta-Processes.** The CMM and the QAF criteria contain a number of what may be considered *meta-process* requirements. Meta-processes, as mentioned in Section 2.3.1, are processes that concern the development, assessment, measurement, improvement, or maintenance of a process. In the CMM, meta-processes are located in *Measurement and Analysis* and *Verifying Implementation*, in addition to certain *KPAs*, such as *Organization Process Definition* and *Process Change Management*, that are designed as meta-processes. A large part of the QAF Criteria falls into the meta-process realm. Categories 2 and 5, in particular, involve meta-processes, but also portions of other categories that mention measuring and improving the respective processes. Meta-processes are specified with one process requirement in the framework, then correlated to all the specific references and once to general references in the models. For instance, the requirement to *Measure Process* can be applied to any process. It is specified once, then correlated to specific references, such as in the CMM Quantitative Process Management Activity 4, and to general references, such as CMM Measurement and Analysis for every Key Process Area.

**4.2.2.3 CMM - Other Common Features.** Processes specified in the *Other Common Features (OCF)* of the CMM are used to help establish and institutionalize production processes in the organization. In describing the institutionalization processes, there are a few key phrases that merit special attention. First is the phrase “the project (*or organization*) follows a written organizational policy ...” from the *Commitment to*

*Perform* OCF [PAUL93b]. It is explicitly stated in the CMM, but is implicitly embodied in the QAF in requirements to align plans, and determine key performance drivers and objectives based on goals. This is not so much a requirement for a process as it is a pre-condition for other required processes. However, it is not listed as a pre-condition to every process requirement. Instead, an explicit process requirement is included once in the framework and correlated to the appropriate references in the models. The second special phrase occurs in the *Ability to Perform* OCF. The phrase is “adequate resources and funding are provided for ...” [PAUL93b]. This phrase also should apply to every process executed in the organization and is not explicitly listed as a pre-condition for each process. Again, it is specified as a separate requirement. The phrases “... are trained ...” and “... receive orientation ...” in the *Ability to Perform* OCF are similar situations and are treated the same way as stated before. Finally, the phrase “... according to a documented procedure” occurs in the *Activities Performed* Common Feature. This phrase is applied to many activities in the CMM to emphasize repeatability and institutionalization [PAUL93b]. The assumption of this analysis is that procedures are documented as part of a process, hence should not be included as an input to the process.

There is one final note on the exclusion of certain conditions or inputs. Although there are some equivalent ideas in the QAF criteria, these phrases are unique to the CMM. Thus including these preconditions and inputs contributes little to the overall integration goal.

**4.2.2.4 Naming Requirements.** The names of the process requirements are generally drawn directly from the models, though in some cases, names are changed to

make them more generic and inclusive. These changes mostly occur with the CMM since process and agent names are domain specific. The term *subcontractor* is used in the CMM, while *supplier* is used in the QAF criteria. This research opts for the more general term, thus *Plan Subcontractor Work* becomes *Plan Supplier Work*.

Consistency in naming process requirements is also an aim. For example, all uses of *Evaluate* should be for similar situations and ideally result in the same output. Specifically, *Evaluate Process* and *Evaluate Supplier* both involve evaluating and both have actions as outputs. Other terms like *Assess*, *Supplier*, *Measure*, and *Review* are used consistently throughout the framework.

**4.2.2.5 Agents versus Inputs.** For the most part, people, or groups of people, are designated as agents in the framework. Agents are those who conduct or perform the processes. In a few cases, however, people or groups are designated as inputs to the process and treated as artifacts. In still other cases, the same people are treated as both agent and input. If the people or group are involved in the process, but take no active part, they are considered as inputs or artifacts. This occurs in situations such as identifying and selecting customer groups. In these cases, an attempt to distinguish between the two is made by naming the agent *Worker* and the input *Member*, for example. *Worker* implies action, whereas *Member* implies belonging. For those processes that employ the same people as agent and input, the same name is used for the agent and input. An instance of this situation is the *Evaluate Member* process requirement. The members being evaluated are included as agents and as inputs to this process. The rationale is that the process is being performed on the members, and the

members play an active role in their evaluations, as in Air Force mandated feedback sessions.

#### *4.2.3 Artifact Types.*

*4.2.3.1 Hierarchy of Data.* Both models require organizations to collect large amounts of relevant process and product data. In this approach, the type *DATA* is used for any data referred to by the models. However, output names uniquely identify the source or the characteristics of the data.

*4.2.3.2 Data and Analysis.* The *DATA* type is used to imply raw data, whereas the *ANALYSIS* type is used to imply analyzed data. Raw data are the primary output of measurement and assessment processes, and the secondary output of various other processes. Raw data are the input to only a few process requirements other than *Analyze Data*. In general, data are assumed to be analyzed before being used by other processes.

*4.2.3.3 Actions.* The *ACTION* type is the output of reviews, evaluations, and audits, along with various other process requirements. As an output of a process requirement, the *ACTION* type is considered a special form of information that describes sets of possible operations to be performed. The type does not imply the actions are actually executed as sub-processes or outputs of a process. For this application, the subtle difference does not have an impact, but the difference would have an impact in building an executable model based on these specifications. Precisely, the decision must be made to view the output actions as operations to perform--in which case the actions may be put on an event queue and eventually executed--or as a special form of information, as in this application.

4.2.3.4 *Products.* The *PRODUCT* type is used for work products and end products. It is a super type that encompasses practically any of the other artifact types in certain situations. A case in point concerns the *REQUIREMENT* type. Product requirements specified by the user are considered of type *REQUIREMENT*, but may also be a *PRODUCT* type when in the form of a software requirements document (SRD). *Review Allocated Requirements* is used to review the allocated requirements, which are the *REQUIREMENT* type, to ensure requirements are feasible, testable, correct, etc. *Review Product* is used to review the SRD, which is a *PRODUCT* type, to ensure the product meets organizationally-established criteria.

4.2.3.5 *Plans and Planning.* The QAF criteria specifies a number of planning processes and the CMM requires a number of plans at the organization and project levels. The importance of plan requirements lies not in the documents themselves, but in the process of planning. The process of planning is fundamentally the same for each of the planning processes; despite this, there are eleven planning requirements in the framework. One process requirement addresses strategic level, or organization planning, another addresses tactical, or project planning. These two process requirements have matching signature and specifications, but it is felt the two demand vastly different considerations and require different skills, and are thus separated. Other planning requirements are very specific to an area, but may employ the same methods. Examples are *Plan Community Involvement*, *Plan Peer Review*, and *Develop Integration Test Plan*.

The *PLAN* type is viewed as a special kind of the *PRODUCT* type. Thus, *Review Product* is an appropriate process requirement to apply to plans. Plans may also be regarded as embodying other artifacts like goals, schedules, processes, requirements, etc.

### 4.3 Results

#### 4.3.1 Intermediate Results.

4.3.1.1 *QAF Criteria.* The QAF Criteria are made up of 7 Categories, 24 Assessment Items, and 54 Areas to Address. Functional decomposition of the QAF criteria results in 148 requirements. Some of the 148 requirements are used more than once to provide complete coverage. Consequently, the QAF criteria are represented by a total of 209 requirements. The exact numbers are not significant since different analysts will make different decisions on how to decompose a particular English paragraph. The numbers do provide general insight into the purpose and intended use of the model. In the QAF criteria, nearly 40 percent of the 148 requirements involve measuring products and processes, analyzing data, evaluating products and processes, or improving them. Close to 25 percent of the distinct requirements correlate to the Process Management category alone. These numbers indicate the emphasis the QAF criteria places on process. About 15 percent relate to the customer, and another 7 percent relate to the supplier.

4.3.1.2 *CMM.* The CMM is comprised of 18 Key Process Areas and 150 Activities to Perform, along with practices in the OCFs. These practices are broken into 190 requirements. Many of the 190 requirements are used more than once to provide complete coverage. Hence, the CMM is represented by a total of 350 requirements. The

majority of the repeat process requirements involves the institutionalization processes referenced in the OCFs. The 190 distinct requirements include a number of requirements addressing the same processes, but from the different perspectives of different maturity levels. This dynamic especially occurs in the areas of project management, process management and improvement, quality management and improvement, and data gathering and analysis.

*4.3.2 Final Set of Integrated Requirements.* The following paragraphs discuss the final results of this application of the requirements matching approach. The final set of integrated requirements are available in Appendix A, with cross references in Appendices B through E.

*4.3.2.1 Signature Matching.* Most of the comparisons between requirements are performed using signature matching and contextual information. As mentioned in Section 4.1.3, signature matching is most efficiently done by using a spreadsheet. Nonetheless, it is important to recognize what operations are actually being performed. Recalling Exact Signature Match from Section 3.4.1, consider Figures 9 and 10, *Measure Process* and *Collect Measurement Data*, respectively.

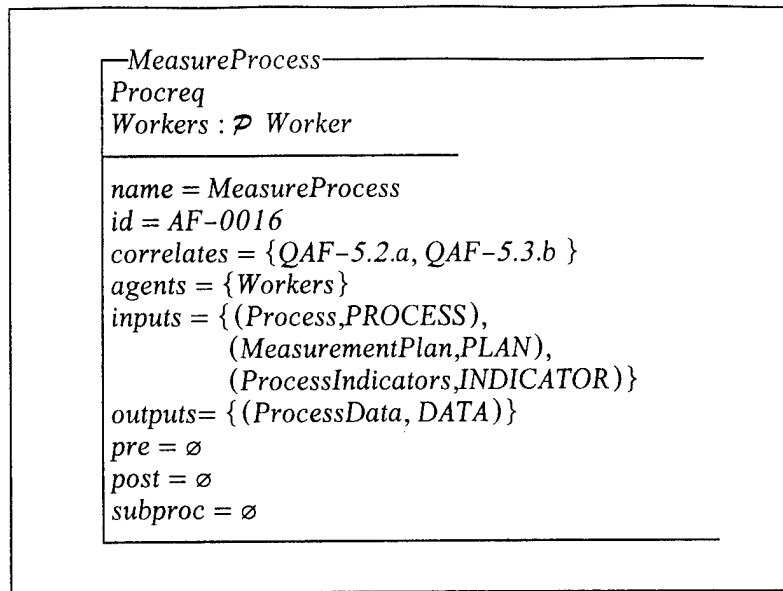


Figure 9 Requirement to Measure Process.

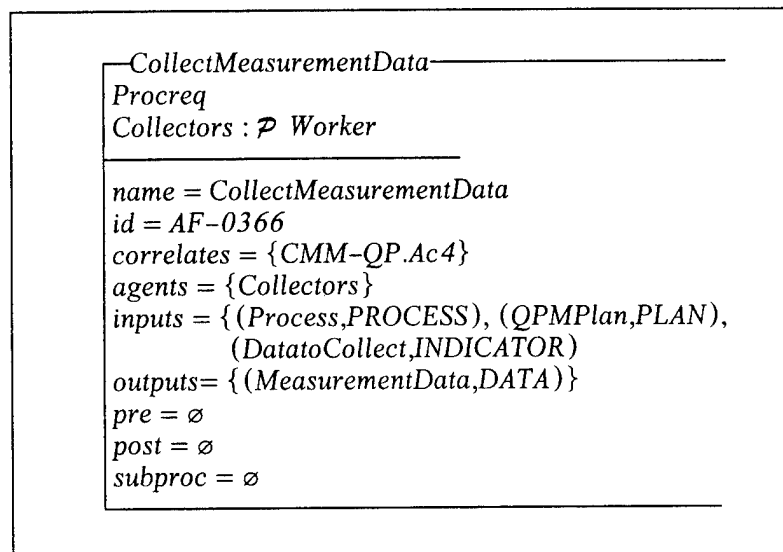


Figure 10 Requirement to Collect Measurement Data

Figure 11 shows that by simply substituting types for artifact names, a comparison can be made between these two process requirements by attempting to satisfy the axioms of the Exact Signature Match. If the axioms are satisfied resulting in a final result of TRUE, the two signatures exactly match. The two process may be redundant.

```

P1 = MeasureProcess
P2 = CollectMeasurementData

MeasureProcess esm CollectMeasurementData ⇔
    ran SQAReview.inputs = ran CollectMeasurementData.inputs ∧
    ran SQAReview.outputs = ran CollectMeasurementData.outputs

MeasureProcess esm CollectMeasurementData ⇔
    {PROCESS,PLAN,INDICATOR} = { PROCESS,PLAN,INDICATOR }
    ∧ { DATA } = {DATA}

MeasureProcess esm CollectMeasurementData ⇔ (TRUE ∧ TRUE)

MeasureProcess esm CollectMeasurementData ⇔ TRUE

```

Figure 11 Application of Exact Signature Match

*Measure Process* and *Collect Measurement Data* are substituted for P<sub>1</sub> and P<sub>2</sub>, respectively. The set of input and output types for *Measure Process* are compared to those of *Collect Measurement Data*. If the sets are equal, Exact Signature Match returns a TRUE, indicating the two signature have identical signatures. It is important to note that the comparison is made based on the type of an input or output, rather than on an arbitrary, albeit informative, name.

The prior example explains the conceptual foundation for matching signatures. However, since the majority of signature matching in this research is performed using a spreadsheet, the example is shown again using the spreadsheet. Table 1 shows a partial listing representing the signatures of *Measure Process* and *Collect Measurement Data*, as well as several other process requirements with DATA as the output type. (The actual spreadsheet includes as many input and output columns as needed. For this research, 7 input and 3 output columns are needed. Other fields such as ID number are also helpful.)

Name	Input1	Input2	Input3	Output1
Measure Activity	Activity	Indicator	Plan	Data
Measure Process	Process	Indicator	Plan	Data
Collect Measurement Data	Process	Indicator	Plan	Data
Measure Leader Involvement	Process	Indicator	Plan	Data
Analyze OSSP	Process	Technology	Requirement	Data
Gather Product Quality Data	Product	Indicator		Data
Measure Product Quality	Product	Indicator		Data
Measure Product	Product	Indicator	Plan	Data
Gather Service Quality Data	Service	Indicator		Data
Gather Supplier Data	Source	Indicator		Data
Gather Financial Data	Source	Indicator		Data

Table 1 Sample Excel Spreadsheet of Process Requirement Signatures.

From this example, it is easy to see that *Measure Process* and *Collect Measurement Data* have matching signatures. Additionally, *Measure Leader Involvement* is identified as a candidate for matching these two requirements. Furthermore, it is clear *Measure Product Quality* and *Gather Product Quality Data* are partial matches with *Measure Product*. A more formal presentation of Partial Signature Match follows in Figures 12-14.

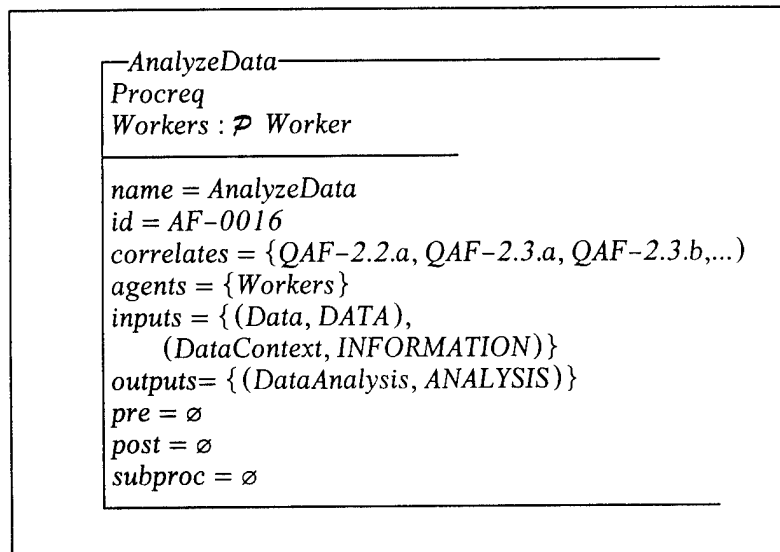


Figure 12 Requirement to Analyze Data

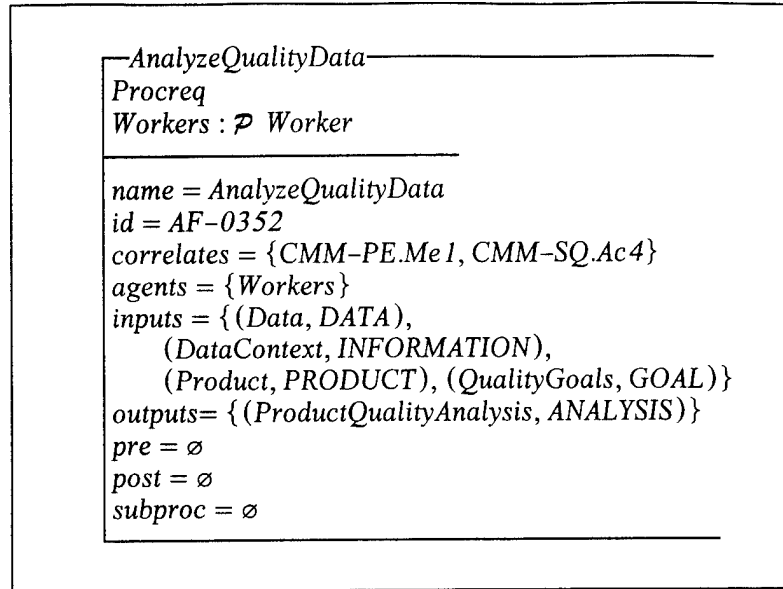


Figure 13 Requirement to Analyze Quality Data

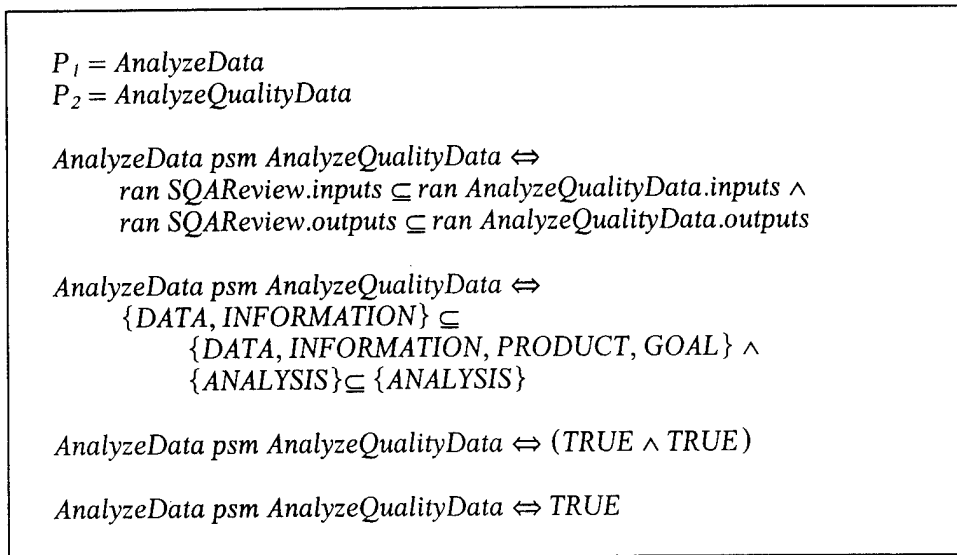


Figure 14 Application of Partial Signature Match.

**4.3.2.2 Specification Matching.** Specification matching is used sparingly in this approach, but is necessary in a few cases. Specification matching is performed manually, much in the way it is presented here (other than signature matching, which is performed using a spreadsheet as described in the last section.)

Figures 15 and 16 contain specifications for *Develop Training Course* from the CMM and *Design Training* from the QAF criteria. Even though the Agents do not exactly match, Exact Specification Match is still satisfied as seen in Figure 17. Neither Exact Specification Match, nor Exact Signature Match consider Agents for a match since it is Agent skills that are important and not the name attached to the Agent. Further discussion of this point is in Section 6.3.1.

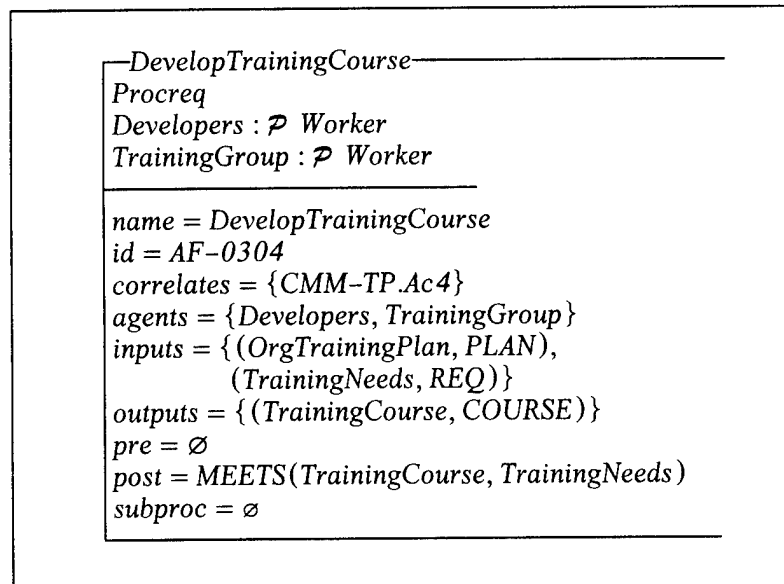


Figure 15 Requirement to Develop Training Course

In Figure 17, the Exact Specification Match is applied to *Develop Training Course* and *Design Training*. Exact Signature Match is applied to ensure the signatures match and the pre-conditions and post-conditions of each requirement are compared to ensure they are equivalent. Moreover, any sub-processes of the two requirements are required to be equal for an exact specification match.

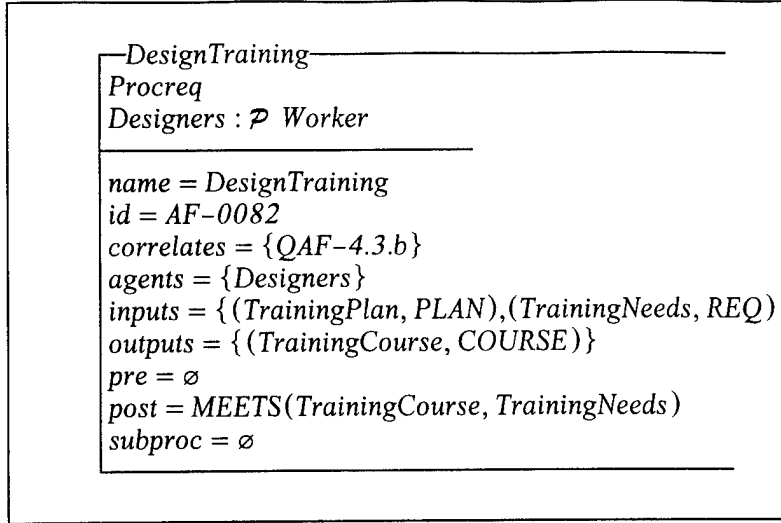


Figure 16 Requirement to Design Training.

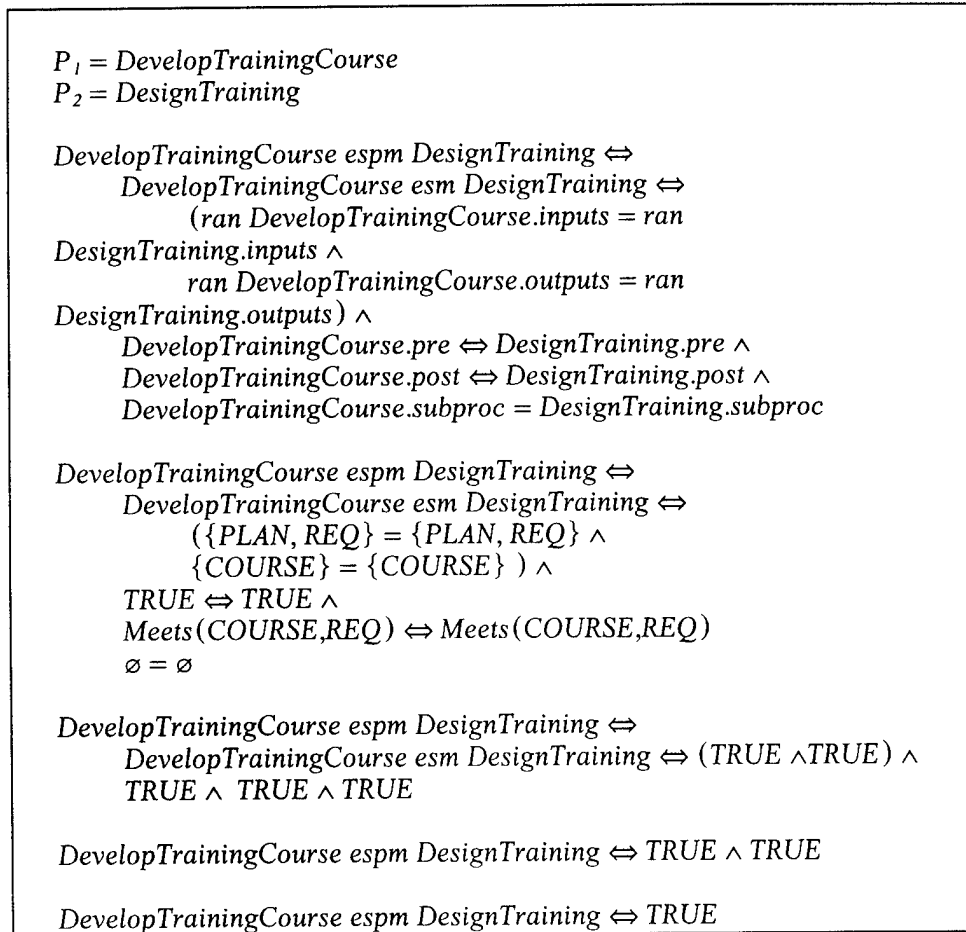


Figure 17 Application of Exact Specification Match.

Figures 18-20 show an example of the Partial Specification Match.

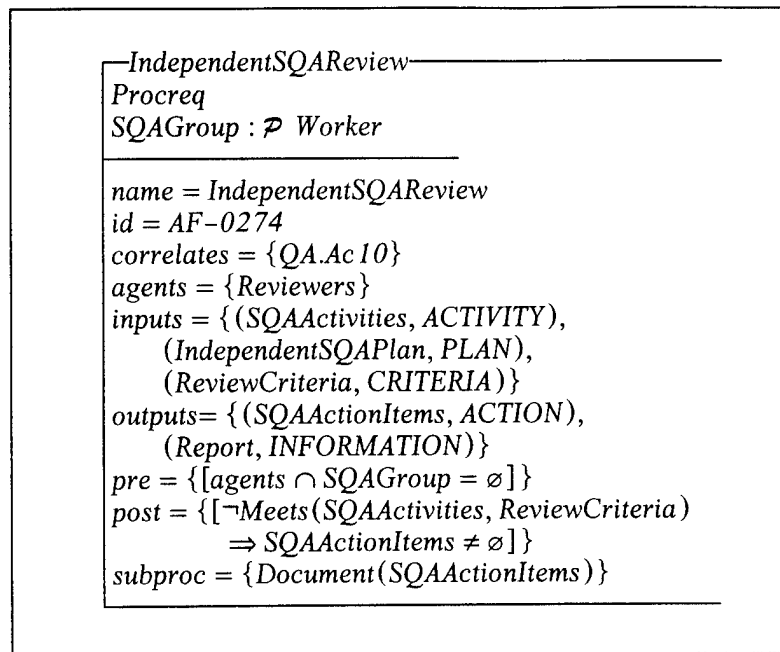


Figure 18 Requirement for Independent SQA Review.

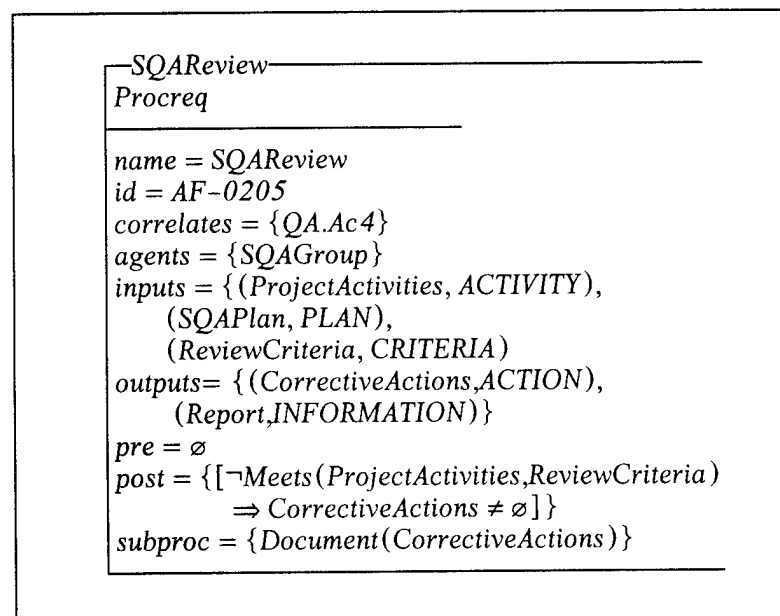


Figure 19 Requirement for SQA Review

As seen here in Figure 20, Partial Specification Match is applied to *SQA Review* and

*Independent SQA Review*:

$$\begin{aligned}
&P_1 = \text{SQAReview} \\
&P_2 = \text{IndependentSQAReview} \\
\\
&\text{SQAReview pspm IndependentSQAReview} \Leftrightarrow \\
&\quad \text{SQAReview psm IndependentSQAReview} \Leftrightarrow \\
&\quad (\text{ran SQAReview.inputs} \subseteq \text{ran IndependentSQAReview.inputs} \wedge \\
&\quad \text{ran SQAReview.outputs} \subseteq \text{ran IndependentSQAReview.outputs}) \\
&\quad \wedge \\
&\quad \text{SQAReview.pre} \Rightarrow \text{IndependentSQAReview.pre} \wedge \\
&\quad \text{IndependentSQAReview.post} \Rightarrow \text{SQAReview.post} \wedge \\
&\quad \text{SQAReview.subproc} \subseteq \text{IndependentSQAReview.subproc} \\
\\
&\text{SQAReview pspm IndependentSQAReview} \Leftrightarrow \\
&\quad \text{SQAReview psm IndependentSQAReview} \Leftrightarrow \\
&\quad (\{\text{ACTIVITY, PLAN, CRITERIA}\} \subseteq \{\text{ACTIVITY, PLAN, CRITERIA}\} \wedge \\
&\quad \{\text{ACTION, INFORMATION}\} \subseteq \{\text{ACTION, INFORMATION}\} \wedge \\
&\quad \text{TRUE} \Rightarrow (\text{GROUP} \cap \text{GROUP} = \emptyset) \wedge \\
&\quad (\neg \text{Meets}(\text{ACTIVITY, CRITERIA}) \Rightarrow \text{ACTION} \neq \emptyset) \Rightarrow \\
&\quad (\neg \text{Meets}(\text{ACTIVITY, CRITERIA}) \Rightarrow \text{ACTION} \neq \emptyset) \\
&\quad \text{Document}(\text{ACTION}) \subseteq \text{Document}(\text{ACTION}) \\
\\
&\text{SQAReview pspm IndependentSQAReview} \Leftrightarrow \\
&\quad \text{SQAReview psm IndependentSQAReview} \Leftrightarrow (\text{TRUE} \wedge \text{TRUE}) \wedge \\
&\quad \text{TRUE} \wedge \text{TRUE} \wedge \text{TRUE} \\
\\
&\text{SQAReview pspm IndependentSQAReview} \Leftrightarrow \text{TRUE} \wedge \text{TRUE} \\
\\
&\text{SQAReview pspm IndependentSQAReview} \Leftrightarrow \text{TRUE}
\end{aligned}$$

Figure 20 Application of Partial Specification Match.

For a successful match, *SQA Review* must be more specific than (or equivalent to) *Independent SQA Review*. In other words, the signature of *SQA Review* must be equal to, or a subset of, the signature of *Independent SQA Review*. The pre-conditions of *SQA Review* must imply the pre-conditions of *Independent SQA Review* and the post-conditions of *Independent SQA Review* must imply the post-conditions of *SQA Review*. Finally, the sub-processes of *SQA Review* must be equal to, or a subset of, the sub-

processes of *Independent SQA Review*. It is important to note that Partial Specification Match also returns TRUE, indicating a match, for two requirements with signatures satisfying Partial Signature Match (but not Exact Signature Match) and specifications that are equivalent.

*4.3.2.3 Final Results.* The final set of integrated requirements consists of 196 distinct process requirements. Of these, 82 are uniquely correlated to the CMM, 71 are uniquely correlated to the QAF criteria, and 43, or about 22 percent, are correlated to both models. At first glance, these numbers seem to indicate a significant, but not overwhelming, relationship between the two models. However, this viewpoint is misleading. A better measure of the relationship depends on the number of QAF requirements that relate to CMM requirements and vice versa. Using this measure, 43 out of 54, or nearly 80 percent, of the QAF Areas to Address relate to CMM practices, while 90 out 150, or 60 percent of the CMM practices relate to QAF Areas to Address. (This does not include practices in the Other Common Features.) The more important relationships are discussed in Section 6.1.

## *V. Verification and Application*

### *5.1 Verification*

In developing software, it is important to ensure each transformation from requirements to design to implementation is accurate. In this research, there are two major transformation steps. The first transformation involves decomposing CMM and QAF requirements into low-level requirements. The second transformation involves integrating these low-level requirements into a single set. As in software development, each of these transformations are verified.

*5.1.1 Decomposed Requirements.* The verification for this step is twofold. One part of the verification is to ensure each element of the CMM and QAF criteria are represented in the respective set of low-level requirements. This check is facilitated by a cross-reference similar to Appendix D or E. The second part of the verification is to ensure each low-level requirement, or group of requirements, accurately defines the respective component from the CMM or QAF criteria. Ideally, this is accomplished by someone other than the one who performed the decomposition. In this effort, this is accomplished by the researcher.

*5.1.2 Integrated Requirements.* After integrating the requirements, it is important to assure the completeness of the integrated set. Appendices B and C are cross-references providing this assurance. Another important part of verifying the integrated set relates to compatibility. The assumption is the two models are compatible, thus the integrated set should represent a set of processes that can be composed together to form systems. For

example, the process improvement system is composed of several processes meeting the requirements given in the integrated set. Figure 21 shows how these processes might be put together to create a process improvement system in the organization.

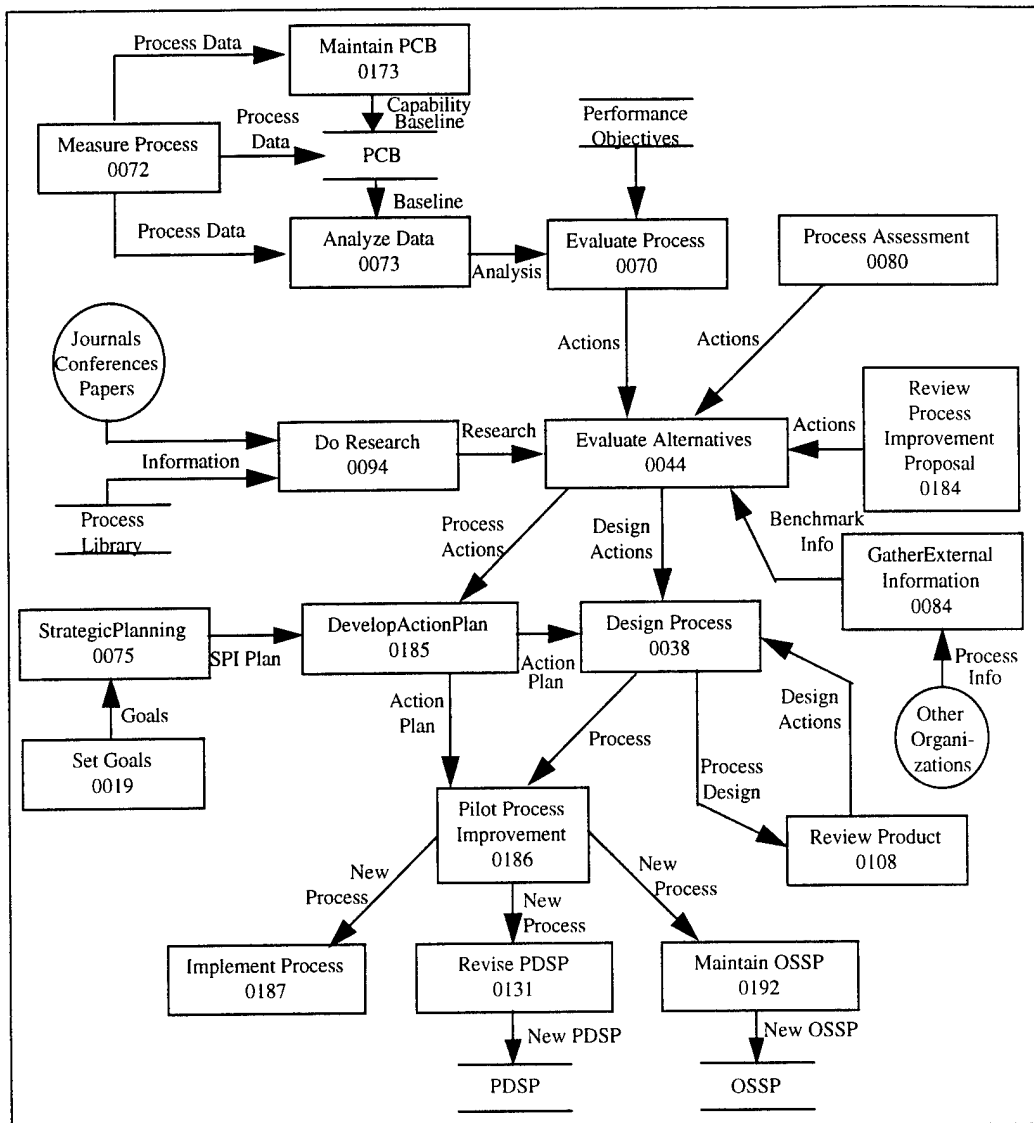


Figure 21 Composition of Processes to Form a Process Improvement System.

This example also illustrates the essence of an organization's Process Asset Library (PAL). The PAL is essentially a reuse library for process components. For a particular

application, the user simply identifies process components that meet requirements, and composes them into processes or systems.

## 5.2 Application

*5.2.1 Overview of SSG's Systems Engineering Process (SEP).* The SEP is a description of the processes used by the Standard Systems Group (SSG) to produce software systems. In terms of the CMM, it is the Organization Standard Software Process, or OSSP. It describes the system lifecycle and provides templates and tailoring guidelines for users. In terms of the QAF Criteria, it contains the designs of the various production and support processes.

The SEP is divided into three phases, designated as Pre-Development, Development, and Post-Development. These phases are subdivided into nine processes. The Development phase consists of five processes, while the other two phases have two processes each. Each process is composed of four stages: Perform Activity, Work Review, Update Project Indicators, and Management Review. These four stages are common to all nine processes across all three phases. The stages are broken into activities, tasks, and procedures, with activities the most general and procedures the most specific [STAN96]. The requirements from the CMM and QAF Criteria are generally at the activity or task level. The SEP does not explicitly identify linkage to either model.

*5.2.2 Applying the Integrated Set of Requirements to the SEP.* In software development, the design phase begins after sufficiently describing the problem domain and restricting the solution space. With the integrated set of process requirements, process design may begin. However, in this application the SEP, or the process design,

already exists. Therefore, the integrated requirements are compared to the SEP to identify linkage from the SEP to either of the models through the integrated set. A sample of this comparison is provided in Table 2 on the following page. Each reference from the SEP is mapped to a process requirement from the integrated set and the appropriate linkage to the models. The mapping is not accomplished by matching signatures or specifications since the SEP does not give inputs and outputs at the activity and task levels. Instead, the mapping is performed by using the integrated requirement information given in the framework, and comparing it to the activities, tasks, and procedures specified in the SEP. Some SEP requirements, such as Negotiate Estimates with Group(s) and Create Project Plan, map very closely to the related integrated requirements. Other requirements in the SEP, like Analyze CSRD and Level of Effort Baseline, are more specific than the integrated requirements. This is to be expected, since the integrated requirements, like the models from which are derived, are meant to be general, reusable requirements that are applied as needed throughout the organization. Additionally, as addressed in Section 1.5.3, there may be requirements for activities, tasks, or procedures in the SEP that are not linked to any requirement in the integrated set.

SEP Reference	Linkage	ID	Level
<b>4.1.1 Needs Analysis: Perform Activity</b>			
Analyze CSRD	RM.Ac1, RM.Ac3, PE.Ac2	AF-0149	Task
Level of Effort Baseline	Ab	AF-0055	Task
POM/Funding Documentation	Ab	AF-0056	Task
<b>4.1.2 Needs Analysis Work Review</b>			
Review Preparation	PR.Ac1	AF-0170	Act
Analyze CSRD	RM.Ac1, RM.Ac3, PE.Ac2	AF-0149	Task
Review Follow-up	RM.Ac1, PE.Ac2	AF-0150	Task
<b>4.2.1 Project Planning: Perform Activity</b>			
Complete SEP Tailoring Worksheet	QA.Ac3, PF.Ac3, IM.Ac1, PE.Ac1	AF-0130	Task
Develop Estimates and Schedules	PP.Ac10, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac7	AF-0134	Task
Develop Estimates and Schedules	PP.Ac10, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac7	AF-0135	Task
Develop Estimates and Schedules	PP.Ac12, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac9	AF-0137	Act
Negotiate estimates with group(s)	PF.Co2, PF.Co3, PF.Ac4, PD.Ac5	AF-0111	Task
Create Project Plans	5.1.a, 5.2.a, 5.3.b, PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1	AF-0114	Act
Project Level Training Plan	4.3.b, TP.Ac1	AF-0089	Task
Test and Evaluation Master Plan	PE.Ac7	AF-0161	Task
<b>4.2.3 Project Planning: Update Project Indicators</b>			
Number of man-hours expended	Me, PT.Ac11	AF-0110	M

Table 2 Sample Mapping of SEP to Integrated Requirements.

The Standard Systems Group, or any other Air Force software organization, can use the integrated set of requirements to determine what processes it needs in its OSSP to satisfy both the CMM and QAF Criteria. The requirements are mapped back to each model, so the organization is able to refer the model to understand the context and subtleties of a process that would satisfy a particular requirement. Thus there may be multiple variations of any particular process. The integrated set of process requirements, along with the two models, provide the basis for designing or acquiring organizational processes.

## VI. Conclusions, Generalization, and Recommendations

### 6.1 Conclusions

The overall goal of this research is to integrate the CMM and QAF criteria. The successful accomplishment of this goal is represented by the integrated set of requirements in Appendix A and the associated cross-references in Appendices B-E. The successful integration of the two models represents a 42% reduction in the number of requirements an organization must manage and meet. This reduction translates into a large savings in the staffing and resources needed to design, implement, and manage the processes required to satisfy the two models.

Intuitively, the two models fit together well since they are both based on the same quality principles. As the 42% reduction shows, the two models are, in fact, strongly linked. As noted in Section 4.3.2.3, nearly 80 percent of the QAF criteria relate to CMM practices, and about 60 percent of the CMM relates to QAF Areas to Address. This should not be too surprising a result, since the QAF criteria is meant to be applied to a wide range of businesses. The CMM, on the other hand, pertains specifically to software, and thus contains many practices that are too domain-specific to appear in the QAF criteria. One example is the requirement to *Develop Software Code*. This requirement obviously does not appear in the QAF criteria. Removing this type of domain-specific requirement increases the CMM-to-QAF linkage to 70 percent.

Some of the relationships consist of using the same process for different purposes. For instance, the *Strategic Planning* requirement calls for a planning process for any strategic level plans, such as the organization's business plans, process improvement plans, or human resource plans. Although some relationships fall into this category, most are much more direct. The *Identify Training Needs* requirements is a one-to-one relationship between a requirement in the CMM (TP.Ac1) and the QAF criteria (4.3.b).

In addition to these direct relationships, there are also implicit relationships among many of the Assessment Items in the QAF criteria and practices or Key Process Areas in the CMM. The more important relationships are expounded below.

*6.1.1 Process Management.* The strongest relationship between the two models emphasizes the process. Category 5.0 of the QAF criteria concerns managing--evaluating and improving--production, support, and supplier processes. The CMM also accentuates the importance of this concept. Organization Process Focus (PF), Organization Process Definition (PD), Quantitative Process Management (QP), and Process Change Management (PC) all relate to managing processes. Nearly all the practices in these key process areas of the CMM are correlated to areas in the QAF. The converse is true for the QAF criteria. One place this is especially evident is the software process improvement example shown in Figure 21 of Section 5.1.2. This system consists of 18 process requirements, 11 from both models, 4 from the CMM, and 3 from the QAF criteria.

Another strong, process-related relationship between the models concerns institutionalizing processes in the organization. The CMM addresses this aspect through OCFs by requiring policies and standards, adequate resources, measurement and analysis,

and verification by senior leaders and quality assurance. The QAF criteria addresses institutionalization by requiring data collection, review, and improvement cycles.

*6.1.2 Training.* Training is another strong link between the two models. Category 4.0 of the QAF criteria address human resources. One aspect crucial to the development of human resources is training. Item 4.3 of the QAF criteria specifically addresses the training aspect. The CMM does not extend beyond training in the Human Resource realm, but the Training Program (TP) ties tightly to the Areas to Address in the QAF criteria. This linkage, in addition to the process management linkage, shows the importance both models place on building infrastructure throughout the organization.

*6.1.3 Supplier Management.* A somewhat surprising linkage between the two models relates to managing suppliers. The CMM refers to this as Subcontractor Management (SM), but there is also some linkage in the InterGroup Coordination (IC) key process area. Many software organizations in the Air Force have trouble relating the SM key process area to its processes. In fact, in software assessments, SM is often considered to be "not applicable." Viewing these practices as supplier processes from the perspective of the QAF criteria, it is clearly applicable to all Air Force software organizations. There are also references to internal suppliers in the IC key process area. These also are applicable to the QAF Item 5.4.

*6.1.4 Data Gathering.* Data gathering and measurement are addressed in very general terms in both models. This is due to their non-prescriptive natures. Each model tries to guide the organization to make informed decisions about what to measure and why. The linkage between the two models in this area is fairly strong. Both models

identify the kind of measurements to make and give guidance on what to do with the data. Specifically, the *Gather Internal Data* requirement from the QAF criteria and the *Maintain Process Database* requirement from the CMM call for the organization to collect data from across the organization to gain an organizational perspective. This perspective is explicitly called for by the QAF criteria in Item 1.2, and implicitly in the CMM in the Process Definition and Process Change key process areas.

*6.1.5 Plans.* One area that is not so clear pertains to plans. The CMM is rife with requirements for informal and formal plans. The essence is to “plan the work and work the plan.” However, the sheer number of plans is quite large. In the QAF Criteria, the verbiage leads the organization to place more focus on the planning process rather than the output plan. In any case, it is a matter of judgment for the organization to determine which plans are necessary and which are of little or no value. In the integrated set of requirements, there are two major planning requirements, *Strategic Planning* and *Project Planning*, in addition to several other more specific requirements such as *Plan Community Involvement* and *Develop Software Risk Management Plan*.

## *6.2 Generalization*

This approach may be used to integrate any kind of requirements, including software requirements and security requirements. Formally specified software requirements may be integrated using the signature and specification matching of this approach. Just like examples given by Zaremski [ZARE95a, ZARE95b] for software code components, any software requirements may be matched to ensure consistency and eliminate redundancy.

Security requirements are often a concern in military systems. These requirements can be integrated along with other requirements to ensure a software system completely addresses software requirements, as well as security requirements. A possible place of application would be in comparing security requirements to configuration management requirements. Configuration management involves controlling access, which security for software systems also addresses. This approach would ensure both sets of requirements are addressed while eliminating redundancy.

### *6.3 Recommendations*

*6.3.1 Use Object Modeling Technique (OMT).* One very promising avenue for extending this approach relies on the object modeling technique (OMT) espoused by Rumbaugh [RUMB91]. OMT is an object-oriented method for analyzing, designing, and implementing software systems. The following sections describe how the results of this approach relate OMT, in general, and how they specifically relate to the Hibdon model mentioned in Section 4.1.4.

*6.3.1.1 Relationship to OMT.* The process requirements that result from this approach are easily modeled using Rumbaugh's OMT. Each particular process requirement is an instance of the process requirement class. Requirements can be aggregated together, as appropriate, to form the key requirements for projects, sub-systems, or whole organizations. The software process improvement sub-system shown in Figure 21 is an excellent example. The process requirements, i.e., process objects, are

composed together to form the fundamental requirements for the software process improvement sub-system.

Process objects can be aggregates of sub-processes, tasks, or procedures. Special relationships between process requirements, such as those between *Measure Process* and *Evaluate Process* can be shown explicitly in the OMT. Furthermore, other objects needed to model an organization, such as people and tools, can be included in the model along with relationships to the process requirement objects. This is the type of model Hibdon uses to represent an Air Force wing [HIBD95].

*6.3.1.2 Relationship to Hibdon's Model.* Hibdon uses OMT to create an organizational model of an Air Force wing, and then goes on to describe how the model is generalized to most any type of organization. His model consists of a *ToolSet*, a *ManningPlan*, a *Workforce*, and any number of *Projects* [HIBD95], which agrees closely with the Software Engineering Institute's view of a software organization consisting of people, process, and technology integrated into a system to produce software [NEXT92]. Thus Hibdon's model may be used to provide an infrastructure to compose the integrated set of requirements into a full-blown organization with a variety of projects and sub-systems, as described in the previous section. The following paragraph describes some of the relationships between Hibdon's model and the integrated set of requirements.

Hibdon identifies the most basic objects in his model as *Tool*, *Worker*, *Position*, and *Job*, [HIBD95]. No specific tools are addressed in the integrated set; however, there are requirements that relate to measuring, evaluating, and improving technology in the project or organization. Requirements like *Identify Technology Change Areas* would

operate on the *Tool* object or the *ToolSet* that contains it. Similarly, there are requirements that would operate on the *Worker* object such as *Evaluate Member*, and one that would operate on the *Workforce* object such as *Assess Workforce Motivation*. The *Position* object relates closely to the *Agent* field in the integrated set. The *Agent* field identifies roles needed for a particular task, and the *Position* object likewise identifies the skills a particular worker has. The *qualified\_for* association in Hibdon's model provides the linkage between these two concepts, although the association is between a *Worker* and a *Job*. The *Job* object is at a lower level of detail than any of the process requirements. The process requirements relate more closely to the *Task* object, but do have some relationship the *Job* object, as seen in the last paragraph. Even though Hibdon's model fits very well with the integrated requirements, the exact nature of the many relationships and their implementations in an executable model need more in-depth study to determine the plausibility and benefits of modeling a software organization in this manner.

*6.3.2 Process Asset Library (PAL).* As mentioned earlier, the process asset library, or PAL, is a repository for process assets of the organization. It is essentially the same as a component library for software components. If processes are formally specified, then signature and specification matching can be used to identify and retrieve required processes from the PAL. The concept behind the CMM's Organization's Standard Software Process (OSSP) and Project's Defined Software Process (PDSP) is the same as the PAL. The OSSP is the library of processes for a project to choose and use. Using tailoring guidelines provided in the OSSP, the project manager selects process components to compose into the PDSP. Signature and specification matching provide a

robust search engine for identifying and retrieving the needed process components. Further research into an Air Force-wide PAL with search and retrieval capabilities is recommended.

*6.3.3 Study Data Requirements.* The requirements for collecting and analyzing data in both models are a point for further study. As related to this research, the data requirements for an organization can be determined and compared to guidelines such as the Software Engineering Institute's core measures or the Air Force core measures. These measures give context for requirements to identify what to measure, when, and how. By using the integrated set of requirements in concert with this guidance, Air Force organizations may more easily determine their key performance drivers, the indicators to measure them, and the objectives they want to obtain.

#### *6.4 Final Comments*

This research successfully demonstrates signature and specification matching to integrate the CMM and the Quality Air Force criteria. Appendix A contains a set of requirements integrated from the two models and correlated back to the source for reference purposes. This research shows that the CMM and QAF criteria complement and support each other in concept and in application. Air Force software organizations may use the appendices to this document as resources to determine which requirements they satisfy and which they are missing. By using these resources as the basis for designing organization processes, Air Force software organizations eliminate redundant efforts and save resources, funding, and staffing.

## *Appendix A - Integrated Set of Process Requirements*

### *1.0 Purpose*

The overall purpose of this document is to provide a set of process requirements completely representing the key requirements specified by the Capability Maturity Model for Software (CMM) and the Quality Air Force (QAF) criteria.

### *2.0 Overview*

This document contains 196 process requirements obtained from the CMM and QAF criteria. These process requirements represent all the key requirements specified in both models. This set of requirements is derived by functionally decomposing each model into low-level requirements, comparing the requirements to each other based on signatures and specifications, and eliminating redundancies by integrating matching requirements into single representative requirements. Most matches are identified by matching signatures, or input/output types, while some are identified by matching specifications, or pre-conditions and post-conditions.

Each process requirement is presented in a framework as shown below:

<b>Name</b>	Descriptive name of the process requirement.
<b>ID</b>	Arbitrary identification number assigned as part of managing the requirements.
<b>Purpose</b>	Brief description of the purpose of the process requirement.
<b>Correlates to</b>	Code correlating the process requirement back to one of the original models, i.e., the CMM or QAF criteria. The code key is given in Section 4.
<b>Agents</b>	Descriptive name(s) of people who perform, control, or act in the process.
<b>Inputs</b>	Descriptive name(s) of process artifacts needed to conduct the process.
<b>Outputs</b>	Descriptive name(s) of process artifacts produced by the process.
<b>Entrance Criteria</b>	Pre-conditions that must exist before the process can begin and be successfully performed.
<b>Exit Criteria</b>	Post-conditions that must exist for the process to have finished successfully.
<b>Comments</b>	Explanatory remarks to better understand the process requirement and its use.

### *3.0 Intended Use*

The intended use of this document is as a reference for Air Force software organizations to definitively determine if they are addressing and meeting the process requirements specified by both the CMM and QAF criteria. It is not meant to replace or supplant either model, but rather to supplement and complement both of the models. Toward that end, this document should be used in conjunction with the following associated documents:

- Appendix B    *Capability Maturity Model Relations to Quality Air Force and Integrated Requirements*
- Appendix C    *Quality Air Force Relations to Capability Maturity Model and Integrated Requirements*
- Appendix D    *Capability Maturity Model Map to Integrated Requirements*
- Appendix E    *Quality Air Force Criteria Map to Integrated Requirements*

These are quick-reference mappings of the two models to each other and to the integrated set of requirements contained in this document. This set of five documents may be used in a variety of fashions. The following paragraphs give a brief description of a few possible uses.

*3.1 Start with the Integrated Set.* An organization may start with this document containing the integrated set of requirements. Using the index, the organization is able to identify categories of requirements such as those related to evaluating processes or products, and locate requirements fitting that category. These requirements may be mapped back to the CMM or QAF criteria to determine which activities or areas are met.

*3.2 Start with the CMM.* An organization may start with the CMM as the source of requirements for its software process and may begin implementing processes to meet

those requirements. Using Appendix B, *Capability Maturity Model Relations to Quality Air Force and Integrated Requirements*, and Appendix D, *Capability Maturity Model Map to Integrated Requirements*, the organization is able to identify the requirements in the QAF criteria that it has met, as well as the ones it has not met.

*3.3 Start with the QAF Criteria.* An organization may start with the QAF criteria as the source of requirements for its software process and may begin implementing processes to meet those requirements. Using Appendix C, *Quality Air Force Relations to Capability Maturity Model and Integrated Requirements*, and Appendix E, *Quality Air Force Criteria Map to Integrated Requirements*, the organization is able to identify the requirements in the CMM that it has met, as well as the ones it has not met.

*3.4 Start with the Current Process.* Most organizations have some level of process description accomplished at present. For these organizations (especially those that have an organization process description as described at Maturity Level 3 of the CMM), it may be most beneficial to map the process description to the integrated set of requirements or the converse. From this mapping, the organization will see what requirements from either model are missing from its process descriptions since the integrated set is correlated to both models.

#### *4.0 Guide to Codes*

##### *4.1 Capability Maturity Model Codes.*

###### ***4.1.1 Key Process Areas (KPs):***

RM	Requirements Management
PP	Software Project Planning
PT	Software Project Tracking & Oversight
SM	Software Subcontract Management
QA	Software Quality Assurance
CM	Software Configuration Management
PF	Organization Process Focus
PD	Organization Process Definition
TP	Training Program
IM	Integrated Software Management
PE	Software Product Engineering
IC	InterGroup Coordination
PR	Peer Reviews
QP	Quantitative Process Management
SQ	Software Quality Management
DP	Defect Prevention
TC	Technology Change Management
PC	Process Change Management

###### ***4.1.2 Other Common Features (OCFs):***

Co	Commitment to Perform
Ab	Ability to Perform
Me	Measurement and Analysis
Ve	Verifying Implementation

## *4.2 Quality Air Force Criteria Codes*

### 1.0 Leadership

- 1.1 Senior Executive Leadership
- 1.2 Leadership System and Organization
- 1.3 Public Responsibility and Citizenship

### 2.0 Information and Analysis

- 2.1 Management of Information and Data
- 2.2 Comparisons and Benchmarking
- 2.3 Analysis and Use of Organization-Level Data

### 3.0 Strategic Planning

- 3.1 Strategy Development
- 3.2 Strategic Deployment

### 4.0 Human Resource Development and Management

- 4.1 Human Resource Planning and Evaluation
- 4.2 High Performance Work Systems
- 4.3 Member Education, Training, and Development
- 4.4 Well Being and Satisfaction

### 5.0 Process Management

- 5.1 Design and Introduction of Products and Services
- 5.2 Key Process Management: Product and Service Production  
and Delivery
- 5.3 Process Management: Support Services
- 5.4 Supplier Performance Management

### 6.0 Performance Results

- 6.1 Product and Service Quality
- 6.2 Operational Performance and Financial Results
- 6.3 Supplier Performance Results

## 7.0 Customer Focus and Customer Satisfaction

### 7.1 Customer Knowledge

### 7.2 Customer Management

### 7.3 Customer Satisfaction Determination

### 7.4 Customer Satisfaction Results

### 7.5 Customer Satisfaction Comparison

<b>Name</b>	Develop Organizational Values
<b>ID</b>	AF-0001
<b>Purpose</b>	To develop organizational values based on Air Force values, member values, ethics, standards of conduct, etc.
<b>Correlates to</b>	1.1.a
<b>Agents</b>	Senior Leaders
<b>Inputs</b>	AF Values, Member Values, Customer Values, Ethics, Legalities, Public Concerns
<b>Outputs</b>	Organizational Values
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Set Directions
<b>ID</b>	AF-0002
<b>Purpose</b>	To set organizational directions based on customer requirements, internal and external factors, while considering public concerns
<b>Correlates to</b>	1.1.a
<b>Agents</b>	Senior Leaders
<b>Inputs</b>	Customer Requirements, Customer Expectations, Organizational Data Analysis, External Data Analysis, Public Concerns
<b>Outputs</b>	Organizational Directions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Set Expectations
<b>ID</b>	AF-0003
<b>Purpose</b>	To set organizational expectations based on organizational direction, internal and external environments, and customer requirements
<b>Correlates to</b>	1.1.a
<b>Agents</b>	Senior Leaders
<b>Inputs</b>	Customer Requirements, Organizational Directions, Organizational Data Analysis, External Data Analysis
<b>Outputs</b>	Organizational Expectations
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Review Organizational Performance
<b>ID</b>	AF-0004
<b>Purpose</b>	To find improvement opportunities by reviewing and assessing organizational performance against customer requirements, external factors, and strategic plans.
<b>Correlates to</b>	1.2.c
<b>Agents</b>	Senior Leaders
<b>Inputs</b>	Customer Requirements, Strategic Plans, Organizational Data Analysis, External Data Analysis
<b>Outputs</b>	Organizational Performance Review Actions, Review Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Review Organizational Structure
<b>ID</b>	AF-0005
<b>Purpose</b>	To review the organizational structure with respect to customer requirements and organizational performance, for improvement opportunities
<b>Correlates to</b>	1.2.a, 1.1.b
<b>Agents</b>	Reviewers
<b>Inputs</b>	Organizational Structure, Key Performance Drivers, Organizational Performance Review Actions, Organizational Data Analysis
<b>Outputs</b>	Organizational Structure Review Actions, Review Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Determine Customer Data Requirements
<b>ID</b>	AF-0006
<b>Purpose</b>	To determine customer data requirements such as the types, formats, media, frequency, etc.
<b>Correlates to</b>	2.1.a
<b>Agents</b>	Workers
<b>Inputs</b>	Customer Requirements, Customer Data Analysis
<b>Outputs</b>	Customer Data Requirements
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Determine Benchmarking Requirements
<b>ID</b>	AF-0007
<b>Purpose</b>	To determine benchmarking needs based on processes, organizational goals, and performance drivers
<b>Correlates to</b>	2.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Organizational Goals, Performance Objectives, Organizational Data Analysis
<b>Outputs</b>	Benchmarking Requirements
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Set Benchmarking Priorities
<b>ID</b>	AF-0008
<b>Purpose</b>	To determine benchmarking priorities based on processes, organizational goals, performance drivers, and benchmarking needs
<b>Correlates to</b>	2.2.a
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Organizational Goals, Performance Objectives, Organizational Data Analysis, Benchmarking Requirements
<b>Outputs</b>	Benchmarking Priorities
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Benchmarking Priorities include all Benchmarking Requirements
<b>Comments</b>	

<b>Name</b>	Determine Benchmarking Data Criteria
<b>ID</b>	AF-0009
<b>Purpose</b>	To determine the criteria for selecting benchmarking data based on processes, organizational goals, performance drivers, and benchmarking needs
<b>Correlates to</b>	2.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Performance Indicators, Benchmarking Priorities
<b>Outputs</b>	Benchmarking Data Selection Criteria
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Aggregate Data
<b>ID</b>	AF-0010
<b>Purpose</b>	To aggregate data from across the organization in order to get an organizational perspective of that data.
<b>Correlates to</b>	2.3.a
<b>Agents</b>	Workers
<b>Inputs</b>	Input Data
<b>Outputs</b>	Aggregate Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Build Organizational Capabilities
<b>ID</b>	AF-0011
<b>Purpose</b>	To build organizational capabilities based on customer requirements, external environment, organizational goals, and values
<b>Correlates to</b>	1.1.a, 4.3.a
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Organizational Goals, Organizational Information, Current Capabilities, Customer Requirements
<b>Outputs</b>	Organizational Capabilities
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	This requirement involves a lot of other requirements including training, process improvements, technology management, etc. Linkage between Organizational Capabilities & Customer Requirements is key.

<b>Name</b>	Improve Leadership System
<b>ID</b>	AF-0012
<b>Purpose</b>	To improve the processes which make up the leadership system as a whole.
<b>Correlates to</b>	1.1.b
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Leadership System, Process Improvement Actions, Improvement Priorities, System Data Analysis
<b>Outputs</b>	Leadership System
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Improve Organization Structure
<b>ID</b>	AF-0013
<b>Purpose</b>	To improve how the organization is structured, based on the input actions.
<b>Correlates to</b>	1.1.b, 1.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Organizational Structures, Structure Review Actions
<b>Outputs</b>	Organizational Structures
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Set Objectives
<b>ID</b>	AF-0014
<b>Purpose</b>	To set objective based on higher level goals
<b>Correlates to</b>	3.1.b, PP.Ac7
<b>Agents</b>	Workers
<b>Inputs</b>	Goals
<b>Outputs</b>	Objectives
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	All Goals Supported by Objectives
<b>Comments</b>	

<b>Name</b>	Determine Key Performance Drivers
<b>ID</b>	AF-0015
<b>Purpose</b>	To determine key performance drivers based on customer requirements, organizational plans, and analysis of strategic data.
<b>Correlates to</b>	3.1.b
<b>Agents</b>	Workers
<b>Inputs</b>	Strategic Plans, Customer Requirements, Organizational Data Analysis, External Data Analysis
<b>Outputs</b>	Key Performance Drivers
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Key Performance Drivers are a set of requirements that emphasize what is most important to the organization.

<b>Name</b>	Project Key Indicator Data
<b>ID</b>	AF-0016
<b>Purpose</b>	To project key data 2-5 years in the future based on current and past data.
<b>Correlates to</b>	3.2.b
<b>Agents</b>	Workers
<b>Inputs</b>	Indicators, Current Data, Current Data Analysis, Current Data Context
<b>Outputs</b>	Projected Data
<b>Entrance Criteria</b>	Current Data associates to Indicators
<b>Exit Criteria</b>	
<b>Comments</b>	Indicators may identify any type of data the organization deems important to predicting future performance.

<b>Name</b>	Determine Benefits
<b>ID</b>	AF-0017
<b>Purpose</b>	To determine the benefits due to process improvements by looking at projected data analysis.
<b>Correlates to</b>	3.2.b
<b>Agents</b>	Workers
<b>Inputs</b>	Projected Data Analysis
<b>Outputs</b>	Improvement Benefits
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Evaluate Training
<b>ID</b>	AF-0018
<b>Purpose</b>	To evaluate training and education and the processes that determine how they are delivered.
<b>Correlates to</b>	4.3.a, 4.3.b, TP.Ve3
<b>Agents</b>	Evaluators
<b>Inputs</b>	Training Courses, Training Processes, Training Needs, Training Data Analysis
<b>Outputs</b>	Training Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Training includes education and OJT. The evaluation addresses Training Processes including reinforcement of training, how training is identified, or any other processes associated with training. One key aspect is the linkage between training and organizational capabilities.

<b>Name</b>	Set Goals
<b>ID</b>	AF-0019
<b>Purpose</b>	To set goals at the organizational level based on direction, customer requirements, values, and community concerns.
<b>Correlates to</b>	1.1.a, PC.Ac2, PC.Ac4
<b>Agents</b>	Senior Leaders, Planners
<b>Inputs</b>	Organizational Directions, Customer Requirements, Customer Expectations, Organizational Expectations, Organizational Values, Organizational Capabilities, Supplier Capabilities, Financial Risks, Mission Risks, Technological Risks
<b>Outputs</b>	Organizational Data Analysis, External Data Analysis
<b>Entrance Criteria</b>	Organizational Goals
<b>Exit Criteria</b>	
<b>Comments</b>	Other Planners may be involved, but at the organizational level, Senior Leaders must be deeply involved and be the driver of this process. Not all these Inputs may be applicable or have much impact on a particular organization, but should be considered, as well as any other issues or situations that may affect setting or accomplishing organizational goals.

<b>Name</b>	Assess Community Involvement
<b>ID</b>	AF-0020
<b>Purpose</b>	To determine the quantity and quality of community involvement by the organization.
<b>Correlates to</b>	1.3.b
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Community Involvement Plans, Community Activities
<b>Outputs</b>	Community Involvement Data, Community Involvement Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Senior Leaders may not do the assessment, but the information and data is theirs.

<b>Name</b>	Improve Community Involvement
<b>ID</b>	AF-0021
<b>Purpose</b>	To improve the quantity and/or quality of community involvement activities by the organization.
<b>Correlates to</b>	1.3.b
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Citizenship Goals, Community Actions, Community Activities, Community Data Analysis
<b>Outputs</b>	Community Activities
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Develop Breakthrough Approach
<b>ID</b>	AF-0022
<b>Purpose</b>	To develop or find a design for a process, job, product, service, etc., which vastly improves over the current design. To do research and development.
<b>Correlates to</b>	2.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Benchmarking Priorities, Organizational Data Analysis, External Data Analysis, Process Designs, Service Designs, Product Designs
<b>Outputs</b>	New Approaches, Approach Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	New Approaches are the processes needed to implement breakthroughs. Approach Information contains the expected benefits of the breakthrough.

<b>Name</b>	Assess Member Well-Being
<b>ID</b>	AF-0023
<b>Purpose</b>	To assess the well-being of members of the organization.
<b>Correlates to</b>	4.1.b, 4.4.c
<b>Agents</b>	Workers
<b>Inputs</b>	Members, Organizational Environments, Human Resource Information
<b>Outputs</b>	Well Being Data, Well Being Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Member is distinguished from Worker. The Worker is doing the assessment, the Member is an "artifact" of this process, i.e., the Member is being acted upon, and therefore is an Input.

<b>Name</b>	Assess Member Development
<b>ID</b>	AF-0024
<b>Purpose</b>	To assess the development of members in the organization.
<b>Correlates to</b>	4.1.b, 4.3.b
<b>Agents</b>	Workers
<b>Inputs</b>	Members, Organizational Environments, Human Resource Information
<b>Outputs</b>	Development Data, Development Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Member is distinguished from Worker. The Worker is doing the assessment, the Member is an "artifact" of this process, i.e., the Member is being acted upon, and therefore is an Input.

<b>Name</b>	Improve Work Organization
<b>ID</b>	AF-0025
<b>Purpose</b>	To improve the formal and informal work structures throughout the organization.
<b>Correlates to</b>	4.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Improvement Priorities, Work Organizations, Work Organization Actions
<b>Outputs</b>	Work Organizations
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Job Structures are the way jobs (or processes) are laid out, for example the layout of desktop computers. Work Organizations refer to the way people are organized and relate to each other.

<b>Name</b>	Improve Job Design
<b>ID</b>	AF-0026
<b>Purpose</b>	To improve the formal and informal job structures throughout the organization.
<b>Correlates to</b>	4.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Improvement Priorities, Job Designs, Job Design Actions
<b>Outputs</b>	Job Designs
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Job Structures are the way jobs (or processes) are laid out, for example the layout of desktop computers. Work Organizations refer to the way people are organized and relate to each other.

<b>Name</b>	Recognize Member
<b>ID</b>	AF-0027
<b>Purpose</b>	To recognize members for demonstrating the values of the organization.
<b>Correlates to</b>	1.1.a, 4.2.b
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Members, Organizational Values, Recognition Criteria
<b>Outputs</b>	Recognition
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Organizational Values should relate performance ideals in addition to tenets such as honesty, integrity, duty, honor, country, etc. This is one way to reinforce Organizational Values. Recognition Criteria specify the requirements. Also Relates to informal recognition for which criteria is inappropriate. Although any Worker may recognize other Members, it is incumbent on Senior Leaders to be an integral part of recognition activities.

<b>Name</b>	Compensate Member
<b>ID</b>	AF-0028
<b>Purpose</b>	To compensate members for performing their roles, including special compensations as rewards.
<b>Correlates to</b>	4.2.b
<b>Agents</b>	Workers
<b>Inputs</b>	Members, Member Compensation, Special Compensation
<b>Outputs</b>	Compensated Members
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Compensation may include days off, free time, or special events in the context of military organizations.

<b>Name</b>	Evaluate Member
<b>ID</b>	AF-0029
<b>Purpose</b>	To evaluate members based on the criteria for their jobs and how well the members perform them.
<b>Correlates to</b>	4.2.b
<b>Agents</b>	Evaluators, Members
<b>Inputs</b>	Members, Member Data Analysis, Job Criteria
<b>Outputs</b>	Member Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Job Criteria NOT Met Implies Member Actions Identified
<b>Comments</b>	Members are included as agents to this process, as well as an input. Members should play an active role in their evaluations, e.g. Air Force mandated feedback sessions . This should be considered when choosing processes to meet this requirement.

<b>Name</b>	Improve Training
<b>ID</b>	AF-0030
<b>Purpose</b>	To improve training for organization members and how it is delivered.
<b>Correlates to</b>	4.3.b
<b>Agents</b>	Workers, Training Group
<b>Inputs</b>	Training Courses, Training Processes, Training Actions, Improvement Priorities, Training Data Analysis
<b>Outputs</b>	Training Courses
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Review Work Environment
<b>ID</b>	AF-0031
<b>Purpose</b>	To review the work environment to ensure it is healthy and safe, and to identify actions to improve it.
<b>Correlates to</b>	4.4.a
<b>Agents</b>	Workers
<b>Inputs</b>	Work Environment, Human Resource Data Analysis
<b>Outputs</b>	Work Environment Actions, Work Environment Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Improve Work Environment
<b>ID</b>	AF-0032
<b>Purpose</b>	To improve the work environment in the organization by making it healthier and safer.
<b>Correlates to</b>	4.4.a
<b>Agents</b>	Workers
<b>Inputs</b>	Improvement Priorities, Work Environment, Work Environment Actions
<b>Outputs</b>	Work Environment
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	All Work Environment Actions Addressed
<b>Comments</b>	

<b>Name</b>	Build Workforce Well-Being
<b>ID</b>	AF-0033
<b>Purpose</b>	To improve the well-being of the workforce.
<b>Correlates to</b>	4.4.b
<b>Agents</b>	Workers
<b>Inputs</b>	Members, Improvement Priorities, Workforce Well-Being Actions
<b>Outputs</b>	Members
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	All Workforce Well-Being Actions Addressed
<b>Comments</b>	The "Outputs" are Members with better well-being as measured by Assess Member Well-Being.

<b>Name</b>	Build Workforce Satisfaction
<b>ID</b>	AF-0034
<b>Purpose</b>	To improve the satisfaction of the workforce.
<b>Correlates to</b>	4.4.b
<b>Agents</b>	Workers
<b>Inputs</b>	Members, Improvement Priorities, Workforce Satisfaction Actions
<b>Outputs</b>	Members
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	All Workforce Satisfaction Actions Addressed
<b>Comments</b>	The "Outputs" are Members with greater job satisfaction as measured by Assess Workforce Satisfaction.

<b>Name</b>	Assess Member Services
<b>ID</b>	AF-0035
<b>Purpose</b>	To determine the adequacy of services provided by the organization to its members.
<b>Correlates to</b>	4.4.b
<b>Agents</b>	Workers
<b>Inputs</b>	Member Services, Human Resource Information
<b>Outputs</b>	Member Service Data, Member Service Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Assess Member Facilities
<b>ID</b>	AF-0036
<b>Purpose</b>	To determine the adequacy of facilities provided by the organization to its members.
<b>Correlates to</b>	4.4.b
<b>Agents</b>	Workers
<b>Inputs</b>	Member Facilities, Human Resource Information
<b>Outputs</b>	Member Facility Data, Member Facility Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Assess Member Activities
<b>ID</b>	AF-0037
<b>Purpose</b>	To determine the adequacy of activities provided by the organization for its members.
<b>Correlates to</b>	4.4.b
<b>Agents</b>	Workers
<b>Inputs</b>	Member Activities, Human Resource Information
<b>Outputs</b>	Member Activity Data, Member Activity Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Design Process
<b>ID</b>	AF-0038
<b>Purpose</b>	To support process improvement by improving process designs based on required process actions.
<b>Correlates to</b>	5.1.a, PD.Ac1, PD.Ac2
<b>Agents</b>	Workers
<b>Inputs</b>	Processes, Process Actions, Improvement Plans, Process Requirements
<b>Outputs</b>	Processes
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Processes Meet Process Requirements
<b>Comments</b>	

<b>Name</b>	Design Service
<b>ID</b>	AF-0039
<b>Purpose</b>	To support process improvement by improving service designs.
<b>Correlates to</b>	5.1.a
<b>Agents</b>	Workers
<b>Inputs</b>	Services, Service Actions, Improvement Plans, Service Requirements
<b>Outputs</b>	Services
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Services Meet Service Requirements
<b>Comments</b>	

<b>Name</b>	Maintain Improvement Program
<b>ID</b>	AF-0040
<b>Purpose</b>	To ensure members are empowered to make positive change in the organization.
<b>Correlates to</b>	PF.Co2, PF.Co3, PC.Ac1
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Organization
<b>Outputs</b>	Improvement Program
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Members Empowered
<b>Comments</b>	The program consists of all the improvement processes, plans, and activities. Senior Leaders are primarily responsible for establishing, sponsoring, and maintaining such a program. Workers from the organization participate on an as needed basis, i.e., to serve on improvement teams or process focal group.

<b>Name</b>	Test Product
<b>ID</b>	AF-0041
<b>Purpose</b>	To test the product design to ensure it meets design requirements and performance objectives spelled out in the implementation plan.
<b>Correlates to</b>	5.1.b
<b>Agents</b>	Workers
<b>Inputs</b>	Products, Implementation Plans, Design Requirements
<b>Outputs</b>	Design Actions, Design Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	(Design Requirements NOT Met) OR (Performance Objectives NOT Achieved) Implies Design Actions Identified Design Data Recorded
<b>Comments</b>	Performance Objectives are in the Implementation Plans, and based on design requirements, Key Performance Objectives, and Key Performance Drivers.

<b>Name</b>	Test Service
<b>ID</b>	AF-0042
<b>Purpose</b>	To test the service design to ensure it meets design requirements, performance objectives spelled out in the implementation plan, and determine if there are ways to improve the design before fully implementing it.
<b>Correlates to</b>	5.1.b
<b>Agents</b>	Workers
<b>Inputs</b>	Services, Implementation Plans, Service Design Requirements
<b>Outputs</b>	Service Design Actions, Service Design Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Service Meets Service Design Requirements AND Service Achieves Service Performance Objectives) OR (Service Design Actions Identified)
<b>Comments</b>	Service Data Recorded Service Performance Objectives should be documented as part of the Implementation Plans, and are based on the design requirements, Key Performance Objectives, and Key Performance Drivers.

<b>Name</b>	Determine Root Cause
<b>ID</b>	AF-0043
<b>Purpose</b>	To determine the root cause of a process, product, service problem or variation.
<b>Correlates to</b>	5.2.a, 5.3.b, DP.Ac3, DP.Ac5
<b>Agents</b>	Workers
<b>Inputs</b>	Problem Information, Problem Data Analysis, Variation Data, Requirements, Performance Objectives
<b>Outputs</b>	Root Cause, Proposed Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Root Cause Documented
<b>Comments</b>	For DP.Ac3, Workers include the Defect Prevention Group.

<b>Name</b>	Evaluate Alternatives
<b>ID</b>	AF-0044
<b>Purpose</b>	To evaluate alternative courses of action and choose a set of actions which will eliminate the root cause of variation, keeping in mind requirements and goals of the processes, products, and services involved.
<b>Correlates to</b>	5.2.b, 5.3.c
<b>Agents</b>	Workers
<b>Inputs</b>	Possible Actions, Root Cause, Research, Data Analysis, Key Performance Drivers, Key Performance Objectives
<b>Outputs</b>	Process Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	This requirement may be satisfied by one or more common methods for choosing alternatives, e.g. Nominal Group Technique or Multi-voting. Care must be given to ensure the actions solve or eliminate the root cause.

<b>Name</b>	Build Supplier Relationship
<b>ID</b>	AF-0045
<b>Purpose</b>	To build a strong relationship with suppliers in order to facilitate communication and cooperation between the supplier and the organization.
<b>Correlates to</b>	5.4.b
<b>Agents</b>	Workers
<b>Inputs</b>	Suppliers, Supplier Relationship, Supplier Processes, Supplier Requirements, Supplier Data Analysis
<b>Outputs</b>	Supplier Relationship
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Supplier Relationship implies the infrastructure, i.e. the lines of communication, formal and informal systems, that are the architecture for using processes Supplier Requirements are used for context in understanding the relationship. In a newly formed relationship, or a newly formed focus, the Supplier Relationship information, Supplier Processes and Supplier Data Analysis may be not be available.

<b>Name</b>	Determine Customer Requirements
<b>ID</b>	AF-0046
<b>Purpose</b>	To determine customer requirements for the organization.
<b>Correlates to</b>	7.1.a
<b>Agents</b>	Workers, Customers
<b>Inputs</b>	Customer Expectations, Customer Goals, Customer Information, Customer Data Analysis
<b>Outputs</b>	Customer Requirements
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Customer Requirements Documented
<b>Comments</b>	This requirement differs from AF-0166. It is focused on the problem domain, i.e., determining customer needs. AF-0166 addresses the solution space, i.e. what system is needed. This requirement would normally be fulfilled by requirements elicitation processes, as well as informal discussions and interaction with the customer. Customers are considered Agents of the this process not as Inputs. The subtle difference is as Agents they are active participants that help guide the process; as Inputs are being acted upon by Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement. Customer Information includes Values and Expectations, as well as any other information the organization may have on the customer.

<b>Name</b>	Determine Customer Expectations
<b>ID</b>	AF-0047
<b>Purpose</b>	To determine customer expectations for the organization.
<b>Correlates to</b>	7.1.a
<b>Agents</b>	Workers, Customers
<b>Inputs</b>	Customer Goals, Customer Information, Customer Data Analysis
<b>Outputs</b>	Customer Expectations
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>This requirement concerns expectations the customer has for the organization as a whole, and also to specific expectations related to the work to be done.</p> <p>Customers are considered Agents of this process not Inputs. The subtle difference is that Agents are active participants that help guide the process; Inputs are being acted upon by Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement.</p> <p>Customer Information includes Values, as well as any other information the organization may have on the customer.</p>

<b>Name</b>	Determine Future Customer Requirements
<b>ID</b>	AF-0048
<b>Purpose</b>	To take a long-term approach to meeting customer needs by determining possible future customer requirements based on current requirements, expectations, and customer goals for the future.
<b>Correlates to</b>	7.1.b
<b>Agents</b>	Workers, Customers
<b>Inputs</b>	Customer Goals, Customer Information, Customer Requirements, Projected Customer Data Analysis
<b>Outputs</b>	Future Customer Requirements
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>Customers are considered Agents of this process not Inputs. The subtle difference is that Agents are active participants that help guide the process; Inputs are being acted upon by Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement.</p> <p>Customer Information includes Values and Expectations, as well as any other information the organization may have on the customer.</p>

<b>Name</b>	Determine Future Customer Expectations
<b>ID</b>	AF-0049
<b>Purpose</b>	To take a long term approach to meeting customer needs by determining future customer expectations based on current expectations and customer goals for the future.
<b>Correlates to</b>	7.1.b
<b>Agents</b>	Workers, Customers
<b>Inputs</b>	Customer Goals, Customer Information, Customer Expectations, Projected Customer Data Analysis
<b>Outputs</b>	Future Customer Expectations
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>Customers are considered Agents of this process not Inputs. The subtle difference is that Agents are active participants that help guide the process; Inputs are being acted upon by the Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement.</p> <p>Customer Information includes Values, as well as any other information the organization may have on the customer.</p>

<b>Name</b>	Develop Listening Strategies
<b>ID</b>	AF-0050
<b>Purpose</b>	To develop strategies for learning more about the customer through formal and informal meetings and interactions.
<b>Correlates to</b>	7.1.b
<b>Agents</b>	Workers, Customers
<b>Inputs</b>	Customer Goals, Customer Information, Customer Expectations, Projected Customer Data Analysis
<b>Outputs</b>	Listening Strategies
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>Customers are considered Agents of this process not Inputs. The subtle difference is that Agents are active participants that help guide the process; Inputs are being acted upon by the Agents and may not be seen as part of the team. The difference is important in selecting a process to fulfill the requirement.</p> <p>Customer Information includes Values, as well as any other information the organization may have on the customer.</p>

<b>Name</b>	Evaluate Mission Effectiveness
<b>ID</b>	AF-0051
<b>Purpose</b>	To determine the level of mission effectiveness based on some established measurement scale and determine corrective actions, if necessary.
<b>Correlates to</b>	7.2.c, 7.3.a
<b>Agents</b>	Workers
<b>Inputs</b>	Mission Information, Mission Effectiveness Data Analysis, Measurement Scale
<b>Outputs</b>	Mission Effectiveness Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Evaluate Measurement Scale
<b>ID</b>	AF-0052
<b>Purpose</b>	To evaluate the input measurement scale.
<b>Correlates to</b>	7.3.c
<b>Agents</b>	Workers
<b>Inputs</b>	Measurement Scales, Measurement Scale Criteria, Data Analysis
<b>Outputs</b>	Measurement Scale Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Improve Measurement Scale
<b>ID</b>	AF-0053
<b>Purpose</b>	To improve the measurement scales and how they are used, based on the input actions.
<b>Correlates to</b>	7.3.c
<b>Agents</b>	Workers
<b>Inputs</b>	Measurement Scales, Measurement Scale Actions
<b>Outputs</b>	Measurement Scales
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Follows Policy
<b>ID</b>	AF-0054
<b>Purpose</b>	To ensure alignment of activities and processes performed at every level of the organization with the organizational policies based on the directions, values, expectations, goals of the organization.
<b>Correlates to</b>	Co
<b>Agents</b>	None
<b>Inputs</b>	Process
<b>Outputs</b>	Boolean
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>This is not so much a requirement for a process as it is a pre-condition for other required processes. It is stated in Commitment to Perform in the , but is embodied in the in requirements to align plans, determine key performance drivers and objectives based on goals, and so forth.</p> <p>It may be beneficial to initiate explicit review cycles (like Align Internal Plans) to ensure policies are in place; reflect the organization's goals, values, expectations, and objectives; and are followed at all levels of the organization.</p>

<b>Name</b>	Adequate Resources
<b>ID</b>	AF-0055
<b>Purpose</b>	To ensure a process or activity has the proper resources to be able to accomplish its purpose.
<b>Correlates to</b>	Ab
<b>Agents</b>	None
<b>Inputs</b>	Process
<b>Outputs</b>	Boolean
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>This is not so much a requirement for a process as it is a pre-condition for required processes. It is stated in Ability to Perform in the , but is embodied in the in requirements to review status and feedback into planning processes. The requirement addresses human resources, technology, paper, pencils, etc. Any resource a process requires to meet its purpose.</p> <p>It is beneficial to explicitly address this issue for all processes executed.</p>

<b>Name</b>	Adequate Funding
<b>ID</b>	AF-0056
<b>Purpose</b>	To ensure a process or activity has the proper funding to be able to accomplish its purpose.
<b>Correlates to</b>	Ab
<b>Agents</b>	None
<b>Inputs</b>	Process
<b>Outputs</b>	Boolean
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>This is not so much a requirement for a process as it is a pre-condition for required processes. It is stated in the CMM, but is embodied in the QAF in requirements to review financial status and feedback into planning processes. The requirement addresses money for production processes, but also support processes and business processes.</p> <p>It is beneficial to explicitly address this issue for all processes executed.</p>

<b>Name</b>	Adequate Training
<b>ID</b>	AF-0057
<b>Purpose</b>	To ensure agents of a process or activity have the proper training be able to accomplish its purpose.
<b>Correlates to</b>	Ab
<b>Agents</b>	None
<b>Inputs</b>	Process
<b>Outputs</b>	Boolean
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>This is not so much a requirement for a process as it is a pre-condition for required processes. It is stated in the CMM, but is embodied in the QAF in requirements in Human Resource Planning, specifically the training area. The requirement addresses training and education in all aspects.</p> <p>It is beneficial to explicitly address this issue for all processes executed.</p>

<b>Name</b>	Follows Procedure
<b>ID</b>	AF-0058
<b>Purpose</b>	To ensure institutionalization of standard processes, practices, and activities to provide the basis for quantitative management of processes. A second purpose is to facilitate alignment of activities and processes performed to organizational policies.
<b>Correlates to</b>	Co
<b>Agents</b>	None
<b>Inputs</b>	Process
<b>Outputs</b>	Boolean
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	This is not so much a requirement for a process as it is a pre-condition for other required processes. It is stated in CMM, but is embodied in the QAF in requirements to design, plan, deploy, measure, and manage processes. It may be beneficial to initiate explicit review cycles (similar to those based Align Internal Plans) to ensure procedure are in place and reflect the organization's policies. The specifically requires reviews used to ensure procedures are performed as documented.

<b>Name</b>	Determine Status
<b>ID</b>	AF-0059
<b>Purpose</b>	To determine the status of the activity based on the data collected.
<b>Correlates to</b>	Me
<b>Agents</b>	Workers
<b>Inputs</b>	Activities, Data
<b>Outputs</b>	Project Status
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Allocate Requirements
<b>ID</b>	AF-0060
<b>Purpose</b>	To allocate system requirements to software, hardware, or other system components.
<b>Correlates to</b>	RM.Ab1, RM.Ab2
<b>Agents</b>	Systems Engineering Group, SW Engineering Group, H W Engineering Group
<b>Inputs</b>	System Requirements
<b>Outputs</b>	Allocated Software Requirements, Hardware Requirements, Other Requirements
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	All Requirements Documented
<b>Comments</b>	This may be a responsibility of the Systems Engineering Group, but should have input and involvement from the SW Engineering Group and H W Engineering Group.

<b>Name</b>	Assess Requirements Change
<b>ID</b>	AF-0061
<b>Purpose</b>	To assess the impact of changes to the allocated requirements.
<b>Correlates to</b>	RM.Ac3
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	Allocated Requirements, Change Requirements, Project Data Analysis
<b>Outputs</b>	Impact Data, Impact Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Evaluate Improvement Linkage
<b>ID</b>	AF-0062
<b>Purpose</b>	To analyze the connection between the customer, processes, and improvements. Answers the question, "Are improvements directly related to improving mission effectiveness, customer satisfaction, performance, etc.?"
<b>Correlates to</b>	2.3.b
<b>Agents</b>	Workers
<b>Inputs</b>	Customer Requirements, Processes, Improvement Plans, Organizational Data Analysis,
<b>Outputs</b>	Improvement Actions, Improvement Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Related to assessing processes, but also to aligning plans. The point of this requirement is to ensure improvements directly support the business of the organization. Organizational Data Analysis may be practically any analysis that contributes to understanding these linkages. Specifically, it should include analysis of Customer Data, Mission Effectiveness Data, Performance Data, Quality Data, and Financial Data.

<b>Name</b>	Develop Project Proposal
<b>ID</b>	AF-0063
<b>Purpose</b>	To develop a project proposal which encompasses all areas including hardware, software, and other components of the system.
<b>Correlates to</b>	PP.Ac1
<b>Agents</b>	Proposal Team
<b>Inputs</b>	SOW, Customer Information
<b>Outputs</b>	Proposal
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Customer Information includes Values, Expectations, Goals, etc.

<b>Name</b>	Perform Supplier Acceptance Tests
<b>ID</b>	AF-0064
<b>Purpose</b>	To test the supplier's product to ensure it meets acceptance criteria.
<b>Correlates to</b>	5.4.a, SM.Ac12
<b>Agents</b>	Organization Testers
<b>Inputs</b>	Supplier Products, Acceptance Criteria, Testing Plans, Test Procedures
<b>Outputs</b>	Corrective Actions, Accepted Products
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Handle Deviations
<b>ID</b>	AF-0065
<b>Purpose</b>	To handle process or product deviations.
<b>Correlates to</b>	QA.Ac2, QA.Ac7
<b>Agents</b>	QA Group, Senior Leaders, Affected Groups
<b>Inputs</b>	Software Deviation Actions, Software Work Products, QA Plan
<b>Outputs</b>	Implemented Changes, Status Reports
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	All Actions Tracked to Closure
<b>Comments</b>	Senior Leaders are not a required input to this process. Deviations are elevated to them on an exceptional basis.

<b>Name</b>	Establish CM Library System
<b>ID</b>	AF-0066
<b>Purpose</b>	To establish the CM library system based on the requirements for the project.
<b>Correlates to</b>	CM.Ac2, CM.Ac3
<b>Agents</b>	CM Group
<b>Inputs</b>	Library Requirements, CM Plan
<b>Outputs</b>	CM Library System
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>This requirement may already be fulfilled for each project if an organization uses a standard CM system. However, it should be evaluated to determine if it meets the particular needs of the project.</p> <p>The CM System is a set of processes, tools, procedures, and standards. It is based on requirements listed in Activities 4-10 of the .</p> <p>The CM Library is NOT considered an input to other process requirements.</p>

<b>Name</b>	Identify Software Configuration Items
<b>ID</b>	AF-0067
<b>Purpose</b>	To identify the software configuration items for the project.
<b>Correlates to</b>	CM.Ac2, CM.Ac4
<b>Agents</b>	SW Engineering Group, CM Group
<b>Inputs</b>	Software Development Plan, Software Requirements, Selection Criteria
<b>Outputs</b>	SCIs
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Handle Change Requests
<b>ID</b>	AF-0068
<b>Purpose</b>	To handle change requests or problem reports for software configuration items.
<b>Correlates to</b>	CM.Ac2, CM.Ac5
<b>Agents</b>	SCCB, CM Group
<b>Inputs</b>	Change Requests
<b>Outputs</b>	Approved Change Requests, disapproved Change Requests
<b>Entrance Criteria</b>	Change Requests Documented
<b>Exit Criteria</b>	
<b>Comments</b>	The number of Approved and Disapproved requests should be tracked.

<b>Name</b>	Change Baseline
<b>ID</b>	AF-0069
<b>Purpose</b>	To make changes to software baselines.
<b>Correlates to</b>	CM.Ac2, CM.Ac6
<b>Agents</b>	SW Engineering Group, CM Group
<b>Inputs</b>	Software Baseline, Approved Changes
<b>Outputs</b>	Software Baseline
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Only Approved Changes Made, Regression Tests Passed
<b>Comments</b>	This requirement is related to Configuration Control and ensures there are procedures for making changes to the baseline. It does not address how changes are submitted, approved, or implemented into designs, code, etc.

<b>Name</b>	Evaluate Process
<b>ID</b>	AF-0070
<b>Purpose</b>	To evaluate the input processes against comparable processes and benchmarks and evaluation criteria to identify improvement actions.
<b>Correlates to</b>	1.1.b, 2.1.b, 2.2.b, 3.1.c, 4.1.b, 5.1.c, 5.2.b, 5.3.c, 5.4.b, 7.1.c, 7.2.d, 7.3.c, Ve, SM.Ac13, IM.Ac11
<b>Agents</b>	Workers
<b>Inputs</b>	Processes, Performance Objectives, External Data Analysis, Process Data Analysis, Process Criteria
<b>Outputs</b>	Process Improvement Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Performance Objectives NOT Achieved) OR (Process Criteria NOT Satisfied)
<b>Comments</b>	Implies Process Improvement Actions Identified

<b>Name</b>	Determine Indicators
<b>ID</b>	AF-0071
<b>Purpose</b>	To determine the appropriate indicators based on objectives, priorities and criteria.
<b>Correlates to</b>	2.1.a, 2.2.a, 5.4.a, 7.1.a, QP.Ac3, QP.Ac4
<b>Agents</b>	Workers
<b>Inputs</b>	Performance Drivers, Performance Objectives, Priorities, Criteria
<b>Outputs</b>	Indicators
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Measure Process
<b>ID</b>	AF-0072
<b>Purpose</b>	To collect process data based on the input indicators
<b>Correlates to</b>	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a, QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me
<b>Agents</b>	Workers
<b>Inputs</b>	Processes, Process Indicator, Plans
<b>Outputs</b>	Process Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Process Data Documented in Process Database
<b>Comments</b>	At ML2, Process Database may not be formalized.

<b>Name</b>	Analyze Data
<b>ID</b>	AF-0073
<b>Purpose</b>	To analyze data based on the input criteria and the context of where the data comes from.
<b>Correlates to</b>	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b, PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me
<b>Agents</b>	Workers
<b>Inputs</b>	Input Data, Measured Process, Measured Product, Measurement Criteria, Performance Objectives, Contextual Information
<b>Outputs</b>	Data Analysis
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	<p>Data is analyzed based on its numerical characteristics, as well as the context from which it is gathered. All collected data should be analyzed.</p> <p>Analysis of data includes comparison with other data, i.e. comparisons of benchmarking data, comparative performance data, customer satisfaction data called for by the QAF criteria are all covered by this requirement</p> <p>Methods, tools, and criteria for analyzing data is coordinated at the organization level for ML3 and higher.</p>

<b>Name</b>	Set Performance Objectives
<b>ID</b>	AF-0074
<b>Purpose</b>	To set performance objectives based on data analysis and organizational goals.
<b>Correlates to</b>	2.2.a, SQ.Ac3, QP.Ac1, QP.Ac2, QP.Ac4
<b>Agents</b>	Workers
<b>Inputs</b>	Plan, Data Analysis, Goals
<b>Outputs</b>	Performance Objectives
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Strategic Planning
<b>ID</b>	AF-0075
<b>Purpose</b>	To plan long term strategies for the organization based on goals, customer requirements, expectations, values, capabilities, risks, and analysis internal and external data.
<b>Correlates to</b>	3.1.a, 4.1.a, PF.Ac2, TP.Ac2, TC.Ac1, PC.Ac3
<b>Agents</b>	Senior Leaders, Planners
<b>Inputs</b>	Organizational Goals, Requirements, Environment, Capabilities, Risks, Data Analysis
<b>Outputs</b>	Strategic Plans
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	All Goals Implemented, Plan reviewed
<b>Comments</b>	Planners are the appropriate group at a minimum, e.g. Training Group, Process Focal Group, Technology Change Group, etc. , Some inputs may be empty if not appropriate; however, in most cases all inputs should have some values

<b>Name</b>	Evaluate Job Design
<b>ID</b>	AF-0076
<b>Purpose</b>	To evaluate the structures, methods, and ways of working associated with low-level tasks.
<b>Correlates to</b>	4.2.a, 4.3.b
<b>Agents</b>	Workers
<b>Inputs</b>	HR Plans, HR Performance Drivers, Job Designs, Data Analysis
<b>Outputs</b>	Job Design Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Evaluate Job Design addresses low-level methods and ways of working, such as the desktop arrangements or software interfaces. Evaluate Work Organization addresses high-level interactions, interfaces, and organizations, such as team make-ups and organization charts.

<b>Name</b>	Evaluate Work Organization
<b>ID</b>	AF-0077
<b>Purpose</b>	To evaluate how members are organized, both formally and informally, to accomplish the work and meet customer requirements
<b>Correlates to</b>	1.2.a, 4.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	HR Plans, Performance Drivers, Work Organization, Data Analysis
<b>Outputs</b>	Organization Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Evaluate Work Organization addresses high-level interactions, interfaces, and organizations, such as team make-ups and organization charts. Evaluate Job Design addresses low-level methods and ways of working, such as the desktop arrangements or software interfaces.

<b>Name</b>	Reinforce Organizational Values
<b>ID</b>	AF-0078
<b>Purpose</b>	To ensure the members of the organization know the importance of the values and follow them in conducting their everyday business.
<b>Correlates to</b>	1.1.a
<b>Agents</b>	Senior Leaders
<b>Inputs</b>	Members, Organizational Values
<b>Outputs</b>	Organizational Values
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Communicate Leadership Information
<b>ID</b>	AF-0079
<b>Purpose</b>	For senior leaders to communicate organizational values, expectations, direction, and other relevant information throughout the organization.
<b>Correlates to</b>	1.2.b
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Members, Information
<b>Outputs</b>	Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	All Members Informed
<b>Comments</b>	Workers may aid in communicating this information, but it is up to Senior Leaders to be the primary voice, and to ensure the communication cycle is completed. This is a special case of AF-0097, Communicate Information.

<b>Name</b>	Process Assessment
<b>ID</b>	AF-0080
<b>Purpose</b>	To qualitatively compare a process to a standard, i.e., a set of criteria.
<b>Correlates to</b>	1.1.a, 1.2.c, SM.Ac2, PF.Ac1
<b>Agents</b>	Assessors
<b>Inputs</b>	Processes, Process Criteria
<b>Outputs</b>	Process Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Process Criteria NOT Met Implies Process Actions Identified
<b>Comments</b>	This differs from evaluation, in that it is a qualitative assessment based on criteria, i.e. requirements such as those listed in the CMM, QAF, or QA standards.

<b>Name</b>	Set Citizenship Goals
<b>ID</b>	AF-0081
<b>Purpose</b>	To set goals relating to community involvement and citizenship based on organizational goals and values.
<b>Correlates to</b>	1.3.a
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Public Concerns, Organizational Goals, Organizational Values
<b>Outputs</b>	Citizenship Goals
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Senior Leaders should be the driver of this process.

<b>Name</b>	Assess Community Impact
<b>ID</b>	AF-0082
<b>Purpose</b>	To look at how a new or existing product, service, or process affects people, other organizations, or the community at large.
<b>Correlates to</b>	1.3.a
<b>Agents</b>	Workers
<b>Inputs</b>	Item, Public Concerns
<b>Outputs</b>	Impact Data, Impact Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Plan Community Involvement
<b>ID</b>	AF-0083
<b>Purpose</b>	To plan how the organization can be involved in the local community.
<b>Correlates to</b>	1.3.b
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Citizenship Goals, Community Activities, Community Data Analysis
<b>Outputs</b>	Community Involvement Plans
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Community Involvement Plan Implements Citizenship Goals
<b>Comments</b>	Senior Leaders should be heavily involved in this process.

<b>Name</b>	Gather External Information
<b>ID</b>	AF-0084
<b>Purpose</b>	To gather data and information from external sources to use in benchmarking or comparisons.
<b>Correlates to</b>	2.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Priorities, Indicators, Sources
<b>Outputs</b>	Information, Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Determine Partnering Activities
<b>ID</b>	AF-0085
<b>Purpose</b>	To determine what activities can not or will not be performed by the organization, but will be accomplished by seeking a partner or supplier to perform the activity.
<b>Correlates to</b>	5.4.b, SM.Ac1
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Goals, Current Capabilities, Needed Capabilities, Organizational Data Analysis, External Data Analysis
<b>Outputs</b>	Partnering Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Needed Capabilities NOT Obtainable by the Organization Implies Partnering Actions Identified
<b>Comments</b>	This process may be used at the strategic level, where Goals are organizational, or at the project level, where Goals are the goals of the project. Partnering Actions are those needed to acquired the Needed Capabilities.

<b>Name</b>	Align Plans
<b>ID</b>	AF-0086
<b>Purpose</b>	To review organizational plans to ensure alignment from organizational directions down to implementation of processes to meet customer requirements.
<b>Correlates to</b>	3.2.a, 4.1.b
<b>Agents</b>	Senior Leaders, Workers
<b>Inputs</b>	Organizational Plans, Customer Requirements, Organizational Directions, Organizational Goals, Key Performance Drivers, Key Performance Objectives
<b>Outputs</b>	Alignment Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	This is a requirement for a review cycle in addition to a day-to-day focus. This requirement addresses alignment of Supplier plans also, QAF 3.2.a. Organizational Plans include any plan to include Training Plans, Improvement Plans, Project Plans, Quality Assurance Plans, Measurement Plans, etc.

<b>Name</b>	Reinforce Training
<b>ID</b>	AF-0087
<b>Purpose</b>	To ensure training and education members receive are understood and practiced.
<b>Correlates to</b>	4.3.b
<b>Agents</b>	Workers
<b>Inputs</b>	Members, Training Concerns
<b>Outputs</b>	Capabilities
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	The are a variety of ways to accomplish this, including written tests, performance tests, refresher sessions, etc.

<b>Name</b>	Plan Training Delivery
<b>ID</b>	AF-0088
<b>Purpose</b>	To plan what training and education to accomplish and when, where, and how to accomplish it.
<b>Correlates to</b>	4.3.b, PF.Ac6, TP.Ac1, TP.Ac2
<b>Agents</b>	Trainers, Workers
<b>Inputs</b>	Course, Training Plans, Training Needs
<b>Outputs</b>	Delivery Plans
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	This is essentially implementation planning.

<b>Name</b>	Identify Training Needs
<b>ID</b>	AF-0089
<b>Purpose</b>	To identify training and education needs based on job actions, human resource, plans, and current capabilities.
<b>Correlates to</b>	4.3.b, TP.Ac1
<b>Agents</b>	Workers
<b>Inputs</b>	Job Actions, Human Resource Plans, Workforce Capabilities
<b>Outputs</b>	Training Needs
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Assess Workforce Satisfaction
<b>ID</b>	AF-0090
<b>Purpose</b>	To determine the overall satisfaction of the workforce in the organization.
<b>Correlates to</b>	4.1.b, 4.4.c
<b>Agents</b>	Workers
<b>Inputs</b>	Members, Organizational Environments, Human Resource Information
<b>Outputs</b>	Workforce Satisfaction Data, Workforce Satisfaction Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Assess Workforce Motivation
<b>ID</b>	AF-0091
<b>Purpose</b>	To determine the overall motivation of the workforce in the organization.
<b>Correlates to</b>	4.1.b, 4.4.c
<b>Agents</b>	Workers
<b>Inputs</b>	Members, Organizational Environments, Human Resource Information
<b>Outputs</b>	Workforce Motivation Data, Workforce Motivation Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Evaluate Product Implementation
<b>ID</b>	AF-0092
<b>Purpose</b>	To evaluate a product after implementation to ensure it meets design requirements and performance objectives spelled out in the implementation plan.
<b>Correlates to</b>	5.1.c
<b>Agents</b>	Workers
<b>Inputs</b>	Product, Implementation Plans, Performance Objectives, Product Requirements, Product Data Analysis
<b>Outputs</b>	Product Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Performance Objectives NOT Achieved OR Product Requirements NOT Met Implies Product Actions Identified
<b>Comments</b>	Performance Objectives should be in Implementation Plans, and based on design requirements, Key Performance Objectives, and Key Performance Drivers.

<b>Name</b>	Evaluate Service Implementation
<b>ID</b>	AF-0093
<b>Purpose</b>	To evaluate a Service after implementation to ensure it meets design requirements and performance objectives spelled out in the implementation plan
<b>Correlates to</b>	5.1.c
<b>Agents</b>	Workers
<b>Inputs</b>	Service, Implementation Plans, Performance Objectives, Service Requirements, Service Data Analysis
<b>Outputs</b>	Service Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Performance Objectives NOT Achieved OR Service Requirements NOT Met Implies Service Actions Identified
<b>Comments</b>	Performance Objectives should be in Implementation Plans, and based on design requirements, Key Performance Objectives, and Key Performance Drivers.

<b>Name</b>	Do Research
<b>ID</b>	AF-0094
<b>Purpose</b>	To research information related to a product, process, or service in order to improve it or contribute to alternatives for corrective or improvement actions.
<b>Correlates to</b>	5.2.b, 5.3.c
<b>Agents</b>	Workers
<b>Inputs</b>	Item Concern
<b>Outputs</b>	Research Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	The research may be conducted within the organization, in other organizations, at the library, on the internet, at a conference, etc.

<b>Name</b>	Communicate Supplier Requirements
<b>ID</b>	AF-0095
<b>Purpose</b>	For process owners to communicate requirements to their suppliers, whether internal or external to the organization.
<b>Correlates to</b>	5.4.a, SM.Ac3, IC.Ac3
<b>Agents</b>	Process Owners, Suppliers
<b>Inputs</b>	Supplier Requirements
<b>Outputs</b>	Supplier Requirements
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Suppliers Informed
<b>Comments</b>	

<b>Name</b>	Determine Key Supplier Requirements
<b>ID</b>	AF-0096
<b>Purpose</b>	To determine the key requirements for the supplier of this process.
<b>Correlates to</b>	5.4.a, SM.Ac1, IC.Ac4
<b>Agents</b>	Workers, Suppliers
<b>Inputs</b>	Key Performance Drivers, Key Performance Objectives
<b>Outputs</b>	Supplier Requirements
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Suppliers may be empty for Software Subcontracting Activities.

<b>Name</b>	Communicate Information
<b>ID</b>	AF-0097
<b>Purpose</b>	For one group to communicate information about their activities, products, or performance to other groups, or to provide feedback on another groups activities, products, or performance.
<b>Correlates to</b>	5.4.a, 7.2.a, QA.Ac2, QA.Ac6, QA.Ac8, CM.Ac2, CM.Ac9, PF.Ac7, QP.Ac2, QP.Ac6, DP.Ac8, TC.Ac3, PC.Ac4, PC.Ac10
<b>Agents</b>	Providers
<b>Inputs</b>	Receivers, Information, Plans
<b>Outputs</b>	Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Receivers Informed
<b>Comments</b>	This requires a process for disseminating information about any topic. Information may include reports on activities, performance, products, etc. Most likely there would be several varieties of this process.

<b>Name</b>	Gather Internal Data
<b>ID</b>	AF-0098
<b>Purpose</b>	To gather data from across the organization.
<b>Correlates to</b>	2.3.a, 6.1.a, 6.2.a, PP.Ac15, PD.Ac5
<b>Agents</b>	Workers
<b>Inputs</b>	Sources, Data
<b>Outputs</b>	Internal Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	This is a requirement to report data up the chain to organizational leadership.

<b>Name</b>	Determine Customer Groups
<b>ID</b>	AF-0099
<b>Purpose</b>	To determine groups or segments of customers with the goal of providing products, services, or information to better serve a particular group or segment.
<b>Correlates to</b>	7.1.a, 7.3.a
<b>Agents</b>	Workers, Customers
<b>Inputs</b>	Customer Requirement Sets, Customer Data Analysis Sets
<b>Outputs</b>	Customer Groups
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Select Group
<b>ID</b>	AF-0100
<b>Purpose</b>	To select a group as a supplier or customer for a specific purpose.
<b>Correlates to</b>	7.1.a, SM.Ac2
<b>Agents</b>	Workers
<b>Inputs</b>	Groups, Selection Criteria
<b>Outputs</b>	Selected Groups
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Gather Customer Information
<b>ID</b>	AF-0101
<b>Purpose</b>	To gather, and put into a usable form, various information on the customer, including customer feedback, which may be useful in understand the customer, therefore the customer's requirements, better.
<b>Correlates to</b>	7.1.a, 7.2.b
<b>Agents</b>	Workers
<b>Inputs</b>	Customers, Customer Goals, Customer Expectations, Customer Values, Customer Organization, Customer Requirements, Customer Data, Customer Feedback
<b>Outputs</b>	Customer Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Provide Customer Access
<b>ID</b>	AF-0102
<b>Purpose</b>	To provide the customer with access to information, complaint, or feedback channels related to their relationship with the organization.
<b>Correlates to</b>	7.2.a
<b>Agents</b>	Workers, Customers
<b>Inputs</b>	Customers, Access Processes
<b>Outputs</b>	Customer Access
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Customers are considered as Agents in this process as well as Inputs. It may be the same people or different ones.

<b>Name</b>	Maintain Service Standards
<b>ID</b>	AF-0103
<b>Purpose</b>	To maintain standard levels of service provided to the customer.
<b>Correlates to</b>	7.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Service Standards, Customer Data Analysis, Customer Information
<b>Outputs</b>	Service Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Service Standards NOT Met Implies Service Actions Identified
<b>Comments</b>	

<b>Name</b>	Maintain Product Standards
<b>ID</b>	AF-0104
<b>Purpose</b>	To maintain product standards for products provided to the customer.
<b>Correlates to</b>	7.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Product Standards, Customer Data Analysis, Customer Information
<b>Outputs</b>	Product Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Product Standards NOT Met Implies Product Actions Identified
<b>Comments</b>	

<b>Name</b>	Gather Customer Feedback Data
<b>ID</b>	AF-0105
<b>Purpose</b>	To gather and record feedback data from the customer concerning any of the organization's services, products, processes, standards, etc.
<b>Correlates to</b>	7.2.a
<b>Agents</b>	Workers
<b>Inputs</b>	Customers, Indicators
<b>Outputs</b>	Feedback Data, Customer Information
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Record Customer Complaint
<b>ID</b>	AF-0106
<b>Purpose</b>	To record customer complaints as accurately as possible.
<b>Correlates to</b>	7.2.b
<b>Agents</b>	Workers, Customers
<b>Inputs</b>	Customers, Customer Requirements, Information, Data Analysis
<b>Outputs</b>	Complaints, Complaint Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Evaluate Customer Complaint
<b>ID</b>	AF-0107
<b>Purpose</b>	To determine possible course of action to resolve customer complaints.
<b>Correlates to</b>	7.2.b
<b>Agents</b>	Workers, Customers
<b>Inputs</b>	Complaints, Customer Requirements, Standards, Data Analysis, Information
<b>Outputs</b>	Complaint Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Review Product
<b>ID</b>	AF-0108
<b>Purpose</b>	To review work products and identify actions necessary to remedy problems.
<b>Correlates to</b>	5.1.b, SM.Ac4, QA.Ac2, QA.Ac5, QA.Ac7, IC.Ac5, PR.Ac2, PR.Ac3
<b>Agents</b>	Auditors
<b>Inputs</b>	Work Products, Work Product Criteria, Plan
<b>Outputs</b>	Deviations, Report
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Work Product Criteria NOT Met Implies Deviations Identified AND Documented
<b>Comments</b>	Deviations are of type Action. Reviews can be done on an event-driven basis (for which Plan would be empty), but some should be planned. The process may be used in a variety of manners, e.g., to review subcontractors SDP, a supplier (internal or external) delivery, or a co-worker's efforts.

<b>Name</b>	Review Project Event-Driven
<b>ID</b>	AF-0109
<b>Purpose</b>	To provide leaders with awareness of events that impact the project's activities.
<b>Correlates to</b>	1.2.c, IM.Ac11, Ve
<b>Agents</b>	Leaders, Reviewers
<b>Inputs</b>	Activities, Plans, Data Analysis, Status, Events
<b>Outputs</b>	Corrective Actions, Report
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Plan NOT Followed OR Status Bad Implies Corrective Actions Identified AND Documented
<b>Comments</b>	Leaders are the decision makers, whether a project manager for a project review, or a Senior Leader in an organization-level review. Ve - used as verification for any organization activity.

<b>Name</b>	Measure Activity
<b>ID</b>	AF-0110
<b>Purpose</b>	To collect the data associated with the indicators identified for the input activity.
<b>Correlates to</b>	Me, PT.Ac11
<b>Agents</b>	Workers
<b>Inputs</b>	Activities, Indicators, Plan
<b>Outputs</b>	Activity Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Activity Data Documented in Process Database
<b>Comments</b>	Essentially the same as Measure Process, but may be used for atomic operations. At ML2, Process Database may not be formalized.

<b>Name</b>	Maintain Software Process Database
<b>ID</b>	AF-0111
<b>Purpose</b>	To establish and maintain the organization's software process database.
<b>Correlates to</b>	PF.Co2, PF.Co3, PF.Ac4, PD.Ac5
<b>Agents</b>	SEPG, Senior Leaders, SW Engineering Group
<b>Inputs</b>	Software Process Database, Process Data, Project Data, Organization Data
<b>Outputs</b>	Software Process Database
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software LifeCycle Descriptions Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
<b>Comments</b>	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement. Establish Process Database is NOT included as a separate process requirement since it is a one-time operation. The criteria to "establish" is implicitly met by having a database to maintain. Process Data refers to organizational data collected on the process by ALL projects. Project Data refers to project-specific data that may or may not correlate to other projects. Organization Data refers to other relevant data such as HR data, financial data, or customer data.

<b>Name</b>	Develop Software Requirements
<b>ID</b>	AF-0112
<b>Purpose</b>	To develop software requirements based on the system requirements allocated to software.
<b>Correlates to</b>	RM.Ac2
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	Allocated Requirements
<b>Outputs</b>	Software Requirements
<b>Entrance Criteria</b>	Allocated Requirements Documented AND Managed & Controlled
<b>Exit Criteria</b>	Software Requirements Documented AND Managed & Controlled AND Traceable
<b>Comments</b>	

<b>Name</b>	Change Supplier Commitment
<b>ID</b>	AF-0113
<b>Purpose</b>	To revise the commitment with the supplier.
<b>Correlates to</b>	5.4.b, PT.Ac4, SM.Ac6
<b>Agents</b>	Senior Leaders, Representatives, Supplier Representatives
<b>Inputs</b>	Supplier Commitment, Supplier Requirements, Suggested Changes
<b>Outputs</b>	New Supplier Commitment
<b>Entrance Criteria</b>	Supplier Requirements Documented
<b>Exit Criteria</b>	New Supplier Commitments Documented New Supplier Commitments (Reviewed AND Approved) by Senior Leaders New Supplier Commitments (Communicated OR Agreed To)
<b>Comments</b>	If Supplier is internal, Senior Leaders may not be involved.

<b>Name</b>	Project Planning
<b>ID</b>	AF-0114
<b>Purpose</b>	To perform planning for the entire project, to include action planning, defect prevention, quantitative process management, etc.
<b>Correlates to</b>	5.1.a, 5.2.a, 5.3.b, PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1
<b>Agents</b>	Project Managers, Affected Groups
<b>Inputs</b>	Goals, Objectives, SOW, System Requirements, PDSP, Standards, Commitments
<b>Outputs</b>	Project Plans
<b>Entrance Criteria</b>	SOW (Documented AND Approved) AND Software LifeCycle Identified
<b>Exit Criteria</b>	Project Plans (Documented AND Reviewed AND Approved)
<b>Comments</b>	This is a generic planning process that encompasses all the planning for a project. Even though there are a variety of plans to develop, the process is essentially the same for each one. Also includes revising the plan, i.e., replanning. Not all output plans are necessarily formal plans. For software project planning, Affected Groups must include QA Group. At ML2, PDSP may not be formalized.

<b>Name</b>	Make Commitment
<b>ID</b>	AF-0115
<b>Purpose</b>	To make a commitment with a supplier.
<b>Correlates to</b>	RM.Ac1, RM.Ac3, PP.Ac4, PT.Ac3, SM.Ac3
<b>Agents</b>	Senior Leaders, SW Engineering Group, Suppliers
<b>Inputs</b>	Supplier Requirements, Project Requirements
<b>Outputs</b>	New Supplier Commitments
<b>Entrance Criteria</b>	Supplier Requirements Documented
<b>Exit Criteria</b>	Supplier Commitments (Reviewed AND Approved) by Senior Leaders Supplier Commitments (Documented AND Agreed To)
<b>Comments</b>	Suppliers may be Other Affected Groups in the organization. Project Requirements may be needed as the basis for negotiation, as Supplier Requirements are what they are proposed by the SW Engineering Group. If Supplier is internal, Senior Leaders may not be involved. For external commitments with other groups, AF-0111 is for internal.

<b>Name</b>	Take Corrective Actions
<b>ID</b>	AF-0116
<b>Purpose</b>	To take corrective actions based on problems in the project.
<b>Correlates to</b>	5.2.a, 5.3.b, PT.Ac5, PT.Ac6, PT.Ac7, PT.Ac8, PT.Ac9, PT.Ac10, Ve
<b>Agents</b>	Project Manager, Project Team, Affected Groups
<b>Inputs</b>	Corrective Actions, Priorities, Plan
<b>Outputs</b>	Actions
<b>Entrance Criteria</b>	Corrective Actions Documented AND Approved
<b>Exit Criteria</b>	Corrective Actions (Performed AND Closed)
<b>Comments</b>	Although in the CMM vernacular taking corrective actions implies reaction at ML2, as opposed to "pro"-action at (ML3. However, corrective action as stated here is more general. It applies to any actions taken, including proactive steps. This requirement is applicable to actions taken as a result of an evaluation, audit, or review. Therefore, Ve is included in Correlates to.

<b>Name</b>	Track Technical Activities
<b>ID</b>	AF-0117
<b>Purpose</b>	To track the technical activities of the software development effort and identify corrective actions if there are problems.
<b>Correlates to</b>	PT.Ac9, IC.Ac2
<b>Agents</b>	SW Engineering Group, Affected Groups
<b>Inputs</b>	Software Development Plan, Technical Activities
<b>Outputs</b>	Corrective Actions, Technical Activities Status
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Development Plan NOT Followed Implies Corrective Actions Identified
<b>Comments</b>	

<b>Name</b>	Measure Product
<b>ID</b>	AF-0118
<b>Purpose</b>	To collect product data associated with the indicators identified for the product.
<b>Correlates to</b>	5.4.a, 6.1.a, 6.3.a, PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, SQ.Ac2, SQ.Ac4, DP.Ac5
<b>Agents</b>	Workers
<b>Inputs</b>	Products, Indicators, Plans
<b>Outputs</b>	Product Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Data (Documented in Process Database)
<b>Comments</b>	At ML2, Process Database may not be formalized. At ML3 and higher, methods for using the Process Database are coordinated at the organization level. Most Me measurements in the CMM address measuring activities or process, PE.Me1 addresses products. May also be used for supplier products.

<b>Name</b>	Plan Supplier Work
<b>ID</b>	AF-0119
<b>Purpose</b>	To plan the work the supplier will do.
<b>Correlates to</b>	5.4.b, SM.Ac1
<b>Agents</b>	Senior Leaders, Project Managers, Supplier Managers
<b>Inputs</b>	SOW, Allocated Software Requirements, Software Development Plan, Software Standards, Supplier Procedures
<b>Outputs</b>	Supplier SOW, Supplier Plans
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Supplier Plans Reviewed
<b>Comments</b>	May apply internally. Applied Externally, Senior Leaders should review plans.

<b>Name</b>	Review Activity
<b>ID</b>	AF-0120
<b>Purpose</b>	To independently verify a group is regularly performing activities as planned.
<b>Correlates to</b>	SM.Ac5, SM.Ac8, SM.Ac10, SM.Ac11, QA.Ac2, QA.Ac4, QA.Ac8, IC.Ac7
<b>Agents</b>	Reviewers
<b>Inputs</b>	Workers, Plan, Activities, Status, Review Criteria
<b>Outputs</b>	Action Items, Report
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Review Criteria NOT Met Implies Action Items Identified
<b>Comments</b>	For an Independent Review, ensure no Workers are in Reviewers.

<b>Name</b>	Audit Baseline
<b>ID</b>	AF-0121
<b>Purpose</b>	To perform an audit on a software baseline.
<b>Correlates to</b>	CM.Ac2, CM.Ac10, CM.Ve3
<b>Agents</b>	CM Group, Project Software Manager
<b>Inputs</b>	CM Plan, Software Baseline, CM Library, Baseline Criteria
<b>Outputs</b>	Action Items
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Baseline Criteria NOT Met Implies Action Items Identified
<b>Comments</b>	Baseline Criteria give requirements and standards for the baseline configuration.

<b>Name</b>	Maintain Training Records
<b>ID</b>	AF-0122
<b>Purpose</b>	To maintain the training records of organization personnel.
<b>Correlates to</b>	TP.Ac6
<b>Agents</b>	Training Group,
<b>Inputs</b>	Members, Training Records
<b>Outputs</b>	Updated Records
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Although not specifically addressed, this requirement relates to QAF 4.3.b.

<b>Name</b>	Maintain Software Process Library
<b>ID</b>	AF-0123
<b>Purpose</b>	To establish and maintain the organization's software process library.
<b>Correlates to</b>	PD.Ac6
<b>Agents</b>	Senior Leaders, SEPG, SW Engineering Group
<b>Inputs</b>	Software Process Library, Process Information, Project Information
<b>Outputs</b>	Software Process Library
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Establish is not included as a separate process requirement; the criteria to establish is implicitly met by having a database to maintain.

<b>Name</b>	Perform Training
<b>ID</b>	AF-0124
<b>Purpose</b>	To perform training in accordance with the organization's or project's training plan.
<b>Correlates to</b>	4.3.b, TP.Ac3
<b>Agents</b>	Trainers
<b>Inputs</b>	Participants, Course Materials, Training Plan
<b>Outputs</b>	Course, Capabilities
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Develop Training Course
<b>ID</b>	AF-0125
<b>Purpose</b>	To develop a training course that meets the needs identified in the project or organization training plan.
<b>Correlates to</b>	4.3.b, TP.Ac4
<b>Agents</b>	Developers, Training Group
<b>Inputs</b>	Organization Training Plan, Training Needs
<b>Outputs</b>	Training Course
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Training Course Meets Training Needs
<b>Comments</b>	

<b>Name</b>	Maintain Training Course
<b>ID</b>	AF-0126
<b>Purpose</b>	To update courses to ensure they are current, relevant, and meet training needs
<b>Correlates to</b>	TP.Ac4
<b>Agents</b>	Developers, Training Group, Reviewers
<b>Inputs</b>	Training Course, Change Actions, Organization Training Plan, Training Needs
<b>Outputs</b>	Training Course
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Training Course Meets Training Needs
<b>Comments</b>	

<b>Name</b>	Conduct Training Waiver Procedure
<b>ID</b>	AF-0127
<b>Purpose</b>	To determine if members meet the waiver criteria for a course.
<b>Correlates to</b>	TP.Ac5
<b>Agents</b>	Training Group
<b>Inputs</b>	Members, Training Course, Waiver Criteria
<b>Outputs</b>	Trained Participants
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Waiver Criteria Met Implies Course Waived
<b>Comments</b>	

<b>Name</b>	Measure Training Quality
<b>ID</b>	AF-0128
<b>Purpose</b>	To measure the quality of training offered in and by the organization.
<b>Correlates to</b>	4.3.a, 4.3.b, TP.Me2
<b>Agents</b>	Training Participants, Software Managers, Training Group
<b>Inputs</b>	Training Course, Training Needs, Capabilities
<b>Outputs</b>	Training Quality Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Training Quality should be partly based on the effectiveness of the training to meet Training Needs and build Capabilities.

<b>Name</b>	Independent Training Evaluation
<b>ID</b>	AF-0129
<b>Purpose</b>	To independently evaluate the training program and its effectiveness.
<b>Correlates to</b>	4.3.a, 4.3.b, TP.Ve2
<b>Agents</b>	Evaluators
<b>Inputs</b>	Training Group, Training Plans, Training Activities, Training Courses, Capabilities, Training Needs, Training Records, Training Standards, Training Quality Data
<b>Outputs</b>	Training Actions, Training Analysis
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	This requirement is separate from AF-0120 Activity Review because of the special nature of the training program; however, similar methods may be used. This evaluation should include how the training program contributes to the organizational capabilities that satisfy mission requirements.

<b>Name</b>	Develop PDSP
<b>ID</b>	AF-0130
<b>Purpose</b>	To develop the project's defined software process based on the organization's standard software process and tailoring guidelines.
<b>Correlates to</b>	QA.Ac3, PF.Ac3, IM.Ac1, PE.Ac1
<b>Agents</b>	Developers, Senior Leaders, SEPG, QA Group
<b>Inputs</b>	Software LifeCycle, OSSP, Tailoring Guidelines, Software Engineering Tasks, Software Methods, Software Tools, Selection Criteria
<b>Outputs</b>	PDSP, Process Waivers
<b>Entrance Criteria</b>	Development Activities Coordinated at Organization Level
<b>Exit Criteria</b>	PDSP Reviewed by (SEPG AND QA Group) AND Approved by Senior Leaders PDSP (Reviewed AND Approved) by Senior Leaders Managed & Controlled
<b>Comments</b>	IM Activity 1 relates to developing the PDSP from the OSSP. PE Activity 1 requires the input and consideration of software engineering activities, methods, and tools, as well as the criteria for choosing them. The idea is to integrate these into the PDSP.

<b>Name</b>	Revise PDSP
<b>ID</b>	AF-0131
<b>Purpose</b>	To revise the project's defined software process based on the input changes and the organization's standard software process and tailoring guidelines .
<b>Correlates to</b>	QA.Ac3, PF.Ac3, IM.Ac2, PE.Ac1, DP.Ac7, TC.Ac8
<b>Agents</b>	Developers, Senior Leaders, SEPG, QA Group
<b>Inputs</b>	PDSP, Change Actions, Software LifeCycle, OSSP, Tailoring Guidelines, Software Engineering Tasks, Software Methods, Software Tools, Selection Criteria
<b>Outputs</b>	PDSP, Process Waivers
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	PDSP Reviewed by (SEPG AND QA Group) AND Approved by Senior Leaders PDSP (Reviewed AND Approved) by Senior Leaders Managed & Controlled
<b>Comments</b>	Change Actions include inputs from AF-0043, Determine Root Cause and AF-0179, Analyze OSSP.

<b>Name</b>	Identify Software Work Products
<b>ID</b>	AF-0132
<b>Purpose</b>	To identify software work products necessary to support the development effort.
<b>Correlates to</b>	PP.Ac8, IM.Ac4
<b>Agents</b>	SW Engineering Group, Affected Groups
<b>Inputs</b>	SOW, PDSP, Allocated Requirements, Software LifeCycle, Standards, Software LifeCycle
<b>Outputs</b>	Software Work Products
<b>Entrance Criteria</b>	SOW (Documented AND Approved)
<b>Exit Criteria</b>	Software Work Products Designated (Managed & Controlled OR In CM)
<b>Comments</b>	At ML2, PDSP may not be formalized. This requirement is to identify all software work products that will be needed for the project. AF-0067, Identify Software Configuration Items, identifies a subset of these which will be placed under configuration management.

<b>Name</b>	Estimate Size
<b>ID</b>	AF-0133
<b>Purpose</b>	To estimate size of software work products or changes to software work products.
<b>Correlates to</b>	PP.Ac9, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac6
<b>Agents</b>	Workers, Reviewers
<b>Inputs</b>	PDSP, Software Requirements, Software Work Products, Process Database
<b>Outputs</b>	Size Estimates, Size Thresholds
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Size Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled )
<b>Comments</b>	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds not required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

<b>Name</b>	Estimate Effort
<b>ID</b>	AF-0134
<b>Purpose</b>	To estimate the effort of the software work products or changes to the software work products.
<b>Correlates to</b>	PP.Ac10, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac7
<b>Agents</b>	Workers, Reviewers
<b>Inputs</b>	PDSP, Software Requirements, Software Work Products, Process Database
<b>Outputs</b>	Effort Estimates, Effort Thresholds
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Effort Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled )
<b>Comments</b>	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds not required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

<b>Name</b>	Estimate Cost
<b>ID</b>	AF-0135
<b>Purpose</b>	To estimate the cost of the software work products or changes to the software work products.
<b>Correlates to</b>	PP.Ac10, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac7
<b>Agents</b>	Workers, Reviewers
<b>Inputs</b>	PDSP, Software Requirements, Software Work Products, Process Database
<b>Outputs</b>	Cost Estimates, Cost Thresholds
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Cost Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled )
<b>Comments</b>	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds not required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

<b>Name</b>	Estimate Critical Computer Resources
<b>ID</b>	AF-0136
<b>Purpose</b>	To estimate the critical computer resources necessary to support the project.
<b>Correlates to</b>	PP.Ac11, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac8
<b>Agents</b>	Workers, Reviewers
<b>Inputs</b>	PDSP, Software Requirements, Software Work Products, Process Database
<b>Outputs</b>	Critical Computer Resource Estimates, Critical Computer Resource Thresholds
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Critical Computer Resource Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled )
<b>Comments</b>	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds not required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

<b>Name</b>	Derive Schedule
<b>ID</b>	AF-0137
<b>Purpose</b>	To derive the schedule for the software development effort.
<b>Correlates to</b>	PP.Ac12, PP.Ac15, PF.Ac4, IM.Ac4, IM.Ac5, IM.Ac9
<b>Agents</b>	Workers, Reviewers
<b>Inputs</b>	PDSP, Software Requirements, Software Work Products, Process Database
<b>Outputs</b>	Schedule Estimates, Schedule Thresholds
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Schedule Estimates (Reviewed AND Approved) AND (Documented AND Managed & Controlled )
<b>Comments</b>	Reviewers may include Project Manager, Software Project Manager, and Managers of other affected groups. At ML2, PDSP and Process Database may not be formalized, and Thresholds required outputs. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

<b>Name</b>	Identify Risks
<b>ID</b>	AF-0138
<b>Purpose</b>	To identify potential risks for the software development effort.
<b>Correlates to</b>	PP.Ac13, PP.Ac15, IM.Ac4, IM.Ac5, IM.Ac10
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	PDSP, Software Requirements, Software Work Products, Software Estimates, Software Thresholds, Process Database
<b>Outputs</b>	Software Risks
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Risks Documented AND Managed & Controlled
<b>Comments</b>	At ML2, PDSP and Process Database may not be formalized, and Thresholds may not be produced. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

<b>Name</b>	Analyze Risks
<b>ID</b>	AF-0139
<b>Purpose</b>	To assess the impact of the risks to the software development effort.
<b>Correlates to</b>	PP.Ac13, IM.Ac4, IM.Ac5, IM.Ac10
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	PDSP, Software Requirements, Software Work Products, Software Estimates, Process Database, Software Risks
<b>Outputs</b>	Risk Analysis
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	At ML2, PDSP and Process Database may not be formalized, and Thresholds may not be produced. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

<b>Name</b>	Prioritize Risks
<b>ID</b>	AF-0140
<b>Purpose</b>	To prioritize the risks based on risk analysis.
<b>Correlates to</b>	PP.Ac13, IM.Ac4, IM.Ac5, IM.Ac10
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	PDSP, Software Requirements, Software Work Products, Software Estimates, Process Database, Software Risks, Risk Analysis
<b>Outputs</b>	Prioritized Risks
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Prioritized Risks Documented AND Managed & Controlled
<b>Comments</b>	At ML2, PDSP and Process Database may not be formalized, and Thresholds may not be produced. At ML3 and higher, the methods for using the Process Database are coordinated at the organization level.

<b>Name</b>	Manage Size
<b>ID</b>	AF-0141
<b>Purpose</b>	To manage the size of software work products and identify corrective actions if the actual size data exceeds thresholds.
<b>Correlates to</b>	PT.Ac5, IM.Ac6
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	Software Development Plan, Size Estimates, Size Thresholds, Size Data
<b>Outputs</b>	Corrective Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Size Thresholds Exceeded Implies Corrective Actions Identified
<b>Comments</b>	At ML2, Thresholds may not be produced; Size is "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at ML3 and higher, is used for tracking or managing.

<b>Name</b>	Manage Effort
<b>ID</b>	AF-0142
<b>Purpose</b>	To manage the effort of software work products and identify corrective actions if the actual effort data exceeds thresholds.
<b>Correlates to</b>	PT.Ac6, IM.Ac7
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	Software Development Plan, Effort Estimates, Effort Thresholds, Effort Data
<b>Outputs</b>	Corrective Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Effort Thresholds Exceeded Implies Corrective Actions Identified
<b>Comments</b>	At ML2, Thresholds may not be produced; Effort is "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

<b>Name</b>	Manage Cost
<b>ID</b>	AF-0143
<b>Purpose</b>	To manage the cost of software work products and identify corrective actions if the actual cost data exceeds thresholds.
<b>Correlates to</b>	PT.Ac6, IM.Ac7
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	Software Development Plan, Cost Estimates, Cost Thresholds, Cost Data
<b>Outputs</b>	Corrective Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Cost Thresholds Exceeded Implies Corrective Actions Identified
<b>Comments</b>	At ML2, Thresholds may not be produced; Cost is "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

<b>Name</b>	Manage Critical Computer Resources
<b>ID</b>	AF-0144
<b>Purpose</b>	To manage the critical computer resources of software project and identify corrective actions if the actual critical computer resource data exceeds thresholds.
<b>Correlates to</b>	PT.Ac7, IM.Ac8
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	Software Development Plan, Critical Computer Resource Estimates, Critical Computer Resource Thresholds, Critical Computer Resource Data
<b>Outputs</b>	Corrective Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Critical Computer Resource Thresholds Exceeded Implies Corrective Actions Identified
<b>Comments</b>	At ML2, Thresholds may not be produced; Critical Computer Resources are "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

<b>Name</b>	Manage Critical Paths
<b>ID</b>	AF-0145
<b>Purpose</b>	To manage the critical paths of the project based on the software development plan, estimates, and thresholds.
<b>Correlates to</b>	IM.Ac4, IM.Ac5, IM.Ac9, IC.Ac4
<b>Agents</b>	Software Manager
<b>Inputs</b>	Software Development Plan, Software Estimates, Software Thresholds
<b>Outputs</b>	Corrective Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Thresholds Exceeded Implies Corrective Actions Identified
<b>Comments</b>	At ML2, Thresholds may not be produced; Critical paths may be "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing. The S DP incorporates the schedule and identifies critical paths.

<b>Name</b>	Develop Software Risk Management Plan
<b>ID</b>	AF-0146
<b>Purpose</b>	To develop a comprehensive plan for managing the risks associated with the software development effort and identify contingencies and alternative corrective actions to take should the risk occur or reach a probability threshold of occurring.
<b>Correlates to</b>	IM.Ac10
<b>Agents</b>	SW Engineering Group, Software Managers
<b>Inputs</b>	Software Development Plan, Software Risks, Software Estimates, Software Thresholds, Risk Analysis, Risk Data
<b>Outputs</b>	Software Risk Management Plan
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Risk Management Plan Managed & Controlled
<b>Comments</b>	This plan is part of the S DP; Corrective Actions identified in managing the project may come from this plan.

<b>Name</b>	Manage Risks
<b>ID</b>	AF-0147
<b>Purpose</b>	To manage the risks associated with the software development effort and identify corrective actions to take based on the risk management plan..
<b>Correlates to</b>	PT.Ac10, IM.Ac10
<b>Agents</b>	SW Engineering Group
<b>Inputs</b>	Software Development Plan, Software Risk Management Plan, Software Risks, Software Thresholds, Risk Analysis, Risk Data
<b>Outputs</b>	Corrective Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Risks Occur OR Thresholds Exceeded) Implies Corrective Actions Identified
<b>Comments</b>	At ML2, Thresholds may not be produced; Risks may be "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

<b>Name</b>	Review Project Periodic
<b>ID</b>	AF-0148
<b>Purpose</b>	To determine if actions are needed to bring the project's performance in line with plans, estimates, and business, customer, or end-user needs.
<b>Correlates to</b>	1.2.c, 5.4.a, PP.Ac4, PT.Ac12, PT.Ac13, SM.Ac7, SM.Ac9, IM.Ac11, Ve
<b>Agents</b>	Reviewers
<b>Inputs</b>	Plans, Status, Activities, Estimates, Project Data Analysis, Process Data Analysis, Business Needs, Customer Needs
<b>Outputs</b>	Corrective Actions, Reports
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Corrective Actions (Documented AND Assigned AND Reviewed)
<b>Comments</b>	Corrective Actions are closed under AF-0116, Take Corrective Action

<b>Name</b>	Review Allocated Requirements
<b>ID</b>	AF-0149
<b>Purpose</b>	To ensure system requirements allocated to software are feasible, appropriate, testable, clear, and properly stated.
<b>Correlates to</b>	RM.Ac1, RM.Ac3, PE.Ac2
<b>Agents</b>	Reviewers
<b>Inputs</b>	Allocated Requirements, Criteria, PDSP
<b>Outputs</b>	Approved Requirements, Problem Allocated Requirements
<b>Entrance Criteria</b>	Allocated Requirements Documented
<b>Exit Criteria</b>	Criteria NOT Met Implies Problem Allocated Requirements Identified
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Correct Allocated Requirements
<b>ID</b>	AF-0150
<b>Purpose</b>	To add missing requirements or correct incomplete or problematic requirements, such as one that are not feasible, appropriate, testable, clear, or properly stated.
<b>Correlates to</b>	RM.Ac1, PE.Ac2
<b>Agents</b>	SW Engineering Group, System Requirements Group
<b>Inputs</b>	Problem Allocated Requirements, System Requirements, PDSP
<b>Outputs</b>	Corrected Allocated Requirements
<b>Entrance Criteria</b>	System Requirements Documented AND (Managed & Controlled OR In CM)
<b>Exit Criteria</b>	Problem Allocated Requirements Corrected
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Requirements Analysis
<b>ID</b>	AF-0151
<b>Purpose</b>	To analyze the requirements allocated to software and develop the software requirements for the project.
<b>Correlates to</b>	PE.Ac2
<b>Agents</b>	Analyzers
<b>Inputs</b>	Allocated Requirements, PDSP, Analysis Methods
<b>Outputs</b>	Software Requirements
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Develop Software Requirements Document
<b>ID</b>	AF-0152
<b>Purpose</b>	To develop the software requirements document as the basis for the software component of the project.
<b>Correlates to</b>	PE.Ac2
<b>Agents</b>	Developers
<b>Inputs</b>	Software Requirements, PDSP
<b>Outputs</b>	Software Requirements Document
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Requirements Feasible, Testable, Clear, Consistent, Complete Requirements (Verified AND Validated) Software Requirements Document (Reviewed AND Approved) Software Requirements Document Reviewed with Customers Software Requirements Document In CM
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Develop Design Criteria
<b>ID</b>	AF-0153
<b>Purpose</b>	To develop criteria applicable to the project.
<b>Correlates to</b>	4.3.b, 5.1.a, 5.3.a, PE.Ac3
<b>Agents</b>	Developers
<b>Inputs</b>	Developers, Software Requirements Document, PDSP
<b>Outputs</b>	Software Design Criteria
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Design Criteria (Documented AND Reviewed)
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Develop Software Architecture Design
<b>ID</b>	AF-0154
<b>Purpose</b>	To develop the high-level architectural design of the software product.
<b>Correlates to</b>	5.1.a, PE.Ac3
<b>Agents</b>	Designers
<b>Inputs</b>	Software Requirements Document, Design Criteria, PDSP
<b>Outputs</b>	Software Architecture Design
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Architecture Design (Documented AND Peer Reviewed AND In CM)
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Develop Software Detail Design
<b>ID</b>	AF-0155
<b>Purpose</b>	To develop the low-level detailed design of the software product.
<b>Correlates to</b>	5.1.a, PE.Ac3
<b>Agents</b>	Designers
<b>Inputs</b>	Software Requirements Document, Design Criteria, PDSP, Software Architecture Design
<b>Outputs</b>	Software Detail Design
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Detail Design (Documented AND Peer Reviewed AND In CM)
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Develop Software Code
<b>ID</b>	AF-0156
<b>Purpose</b>	To develop the software code based on the low-level detailed design and the software requirements of the software product.
<b>Correlates to</b>	PE.Ac4
<b>Agents</b>	Coders
<b>Inputs</b>	Software Requirements Document, Design Criteria, PDSP, Software Detail Design
<b>Outputs</b>	Software Code
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Code (Documented AND Peer Reviewed AND In CM)
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Plan Unit Tests
<b>ID</b>	AF-0157
<b>Purpose</b>	To develop the low level testing strategy to ensure the software code components work and meet software requirements of the software product.
<b>Correlates to</b>	PE.Ac5
<b>Agents</b>	Test Planners
<b>Inputs</b>	Software Requirements Document, Software Development Plan, PDSP
<b>Outputs</b>	Software Test Plans, Software Test Procedures, Software Test Cases
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Test Plans, Software Test Procedures, Software Test Cases) Managed & Controlled
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Perform Unit Tests
<b>ID</b>	AF-0158
<b>Purpose</b>	To test the software using the plans, procedures, and cases developed to ensure the software code components work and meet software requirements of the software product.
<b>Correlates to</b>	PE.Ac5
<b>Agents</b>	Testers
<b>Inputs</b>	Software Code, Software Test Plans, Software Test Procedures, Software Test Cases, PDSP
<b>Outputs</b>	Software Components, Software Test Results, Software Test Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Regression Testing Performed Software Components Passed Software Testing
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Plan Integration Tests
<b>ID</b>	AF-0159
<b>Purpose</b>	To develop the integration testing strategy to ensure the software code components work and meet software requirements of the software product.
<b>Correlates to</b>	PE.Ac6
<b>Agents</b>	Integration Test Planners, Testers
<b>Inputs</b>	Software Requirements Document, Software Development Plan, PDSP
<b>Outputs</b>	Integration Test Plans, Integration Test Procedures, Integration Test Cases
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Integration Test Plans, Integration Test Procedures, Integration Test Cases) (Managed & Controlled AND Reviewed by Testers)
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Perform Integration Tests
<b>ID</b>	AF-0160
<b>Purpose</b>	To integrate and test the software components using the plans, procedures, and cases developed to ensure the integrated components work and meet software requirements of the software product.
<b>Correlates to</b>	PE.Ac6
<b>Agents</b>	Testers
<b>Inputs</b>	Software Components, Integration Test Plans, Integration Test Procedures, Integration Test Cases, PDSP
<b>Outputs</b>	Integrated Components, Integration Test Results, Integration Test Data
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Components Passed Software Testing
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Plan System Tests
<b>ID</b>	AF-0161
<b>Purpose</b>	To develop a system level testing strategy to ensure software components work together as a system and meet the requirements of the software product.
<b>Correlates to</b>	PE.Ac7
<b>Agents</b>	System Test Planners, Testers, Customers
<b>Inputs</b>	Software Requirements Document, Software Development Plan, PDSP
<b>Outputs</b>	System Test Plans, System Test Procedures, System Test Cases
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	(System Test Plans, System Test Procedures, System Test Cases) (Managed & Controlled AND Reviewed by (Customers AND Testers))
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Perform System Tests
<b>ID</b>	AF-0162
<b>Purpose</b>	To test the system using plans, procedures, and cases developed to ensure components work together as a system and meet the requirements of the product.
<b>Correlates to</b>	PE.Ac7
<b>Agents</b>	Testers, Customers
<b>Inputs</b>	Integrated Components, System Test Plans, System Test Procedures, System Test Cases, PDSP
<b>Outputs</b>	System Test Data, System Test Results
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Components Passed Software Testing
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Develop Software Documentation
<b>ID</b>	AF-0163
<b>Purpose</b>	To develop the documentation used to describe the software system.
<b>Correlates to</b>	PE.Ac8
<b>Agents</b>	Documenters
<b>Inputs</b>	Software Development Plan, Software Requirements Document, Methods, Tools, Software Baselines, PDSP
<b>Outputs</b>	Software Documentation
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Documentation (Peer Reviewed AND Managed & Controlled) Software Documentation (Reviewed AND Approved) by Customer
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Maintain Software Documentation
<b>ID</b>	AF-0164
<b>Purpose</b>	To maintain the documentation used to describe the software system.
<b>Correlates to</b>	PE.Ac8
<b>Agents</b>	Documenters
<b>Inputs</b>	Software Documentation, Change Actions, Software Development Plan, Software Requirements Document, Methods, Tools, Software Baselines, PDSP
<b>Outputs</b>	Software Documentation
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Documentation (Peer Reviewed AND Managed & Controlled) Software Documentation (Reviewed AND Approved) by Customer
<b>Comments</b>	At ML2, PDSP may not be formalized.

<b>Name</b>	Maintain Consistency
<b>ID</b>	AF-0165
<b>Purpose</b>	To maintain consistency from allocated requirements through software requirements, architectural and detail designs, coding, testing, and documentation.
<b>Correlates to</b>	PE.Ac10
<b>Agents</b>	Workers
<b>Inputs</b>	Software Work Products, Software Documentation
<b>Outputs</b>	Corrective Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Work Products, Software Documentation NOT Consistent Implies Corrective Actions Identified
<b>Comments</b>	

<b>Name</b>	Establish System Requirements
<b>ID</b>	AF-0166
<b>Purpose</b>	To involve the customer and all affected groups in establishing the requirements for the system.
<b>Correlates to</b>	7.1.a, IC.Ac1
<b>Agents</b>	SW Engineering Group, Customers, Affected Groups
<b>Inputs</b>	SW Engineering Group, Customers, Affected Groups, Customer Information, Customer Data
<b>Outputs</b>	System Requirements, Acceptance Criteria
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	This requirement differs from AF-0046. It is focused on the solution space, i.e., what system is needed. AF-0046 addresses the problem domain, i.e., determining customer needs. Elicitation processes may be used for this, also.

<b>Name</b>	Coordinate Technical Activities
<b>ID</b>	AF-0167
<b>Purpose</b>	To coordinate the activities of the engineering groups with other affected groups.
<b>Correlates to</b>	IC.Ac2
<b>Agents</b>	SW Engineering Group, Affected Groups
<b>Inputs</b>	Inter Group Coordination Plan
<b>Outputs</b>	Technical Activities
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Resolve Inter Group Issues
<b>ID</b>	AF-0168
<b>Purpose</b>	To resolve issues between the engineering group and other affected groups.
<b>Correlates to</b>	IC.Ac2, IC.Ac6
<b>Agents</b>	SW Engineering Group, Affected Groups
<b>Inputs</b>	Inter Group Issues, Inter Group Coordination Plan
<b>Outputs</b>	Resolution Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Manage Schedule
<b>ID</b>	AF-0169
<b>Purpose</b>	To manage the schedule of the project and identify corrective actions if the schedule exceeds thresholds. Another aspect of this requirement is to manage the critical dependencies between the engineering group and other affected groups.
<b>Correlates to</b>	PT.Ac8, IC.Ac4, IM.Ac9
<b>Agents</b>	SW Engineering Group, Affected Groups
<b>Inputs</b>	Software Development Plan, Inter Group Coordination Plan, Schedule Estimates, Schedule Thresholds, Schedule Data
<b>Outputs</b>	Corrective Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Schedule Thresholds Exceeded Implies Corrective Actions Identified
<b>Comments</b>	Inter Group Coordination Plan contains the critical dependencies between the SW Engineering Group and other Affected Groups. At ML2, Thresholds may not be produced; Schedule is "tracked". The PDSP is used in planning and estimating, but the S DP, which embodies the PDSP at (ML3, is used for tracking or managing.

<b>Name</b>	Plan Peer Review
<b>ID</b>	AF-0170
<b>Purpose</b>	To plan a peer review of software work products during the software lifecycle.
<b>Correlates to</b>	PR.Ac1
<b>Agents</b>	Planners
<b>Inputs</b>	Software Development Plan, Software Work Products
<b>Outputs</b>	Peer Review Plan
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software Work Products Identified
<b>Comments</b>	

<b>Name</b>	Develop Measurement Analysis Strategy
<b>ID</b>	AF-0171
<b>Purpose</b>	To develop a strategy for measuring and analyzing process quality data.
<b>Correlates to</b>	QP.Ac3
<b>Agents</b>	Workers
<b>Inputs</b>	PDSP, Identified Software Work Products, Product Indicators
<b>Outputs</b>	Measurement Analysis Strategy
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Analyze PDSP
<b>ID</b>	AF-0172
<b>Purpose</b>	To analyze the project's defined software process against expected values to determine if it is within tolerances.
<b>Correlates to</b>	QP.Ac2, QP.Ac5
<b>Agents</b>	Analyzers
<b>Inputs</b>	PDSP, Measurement Data Analysis, Analysis Activities, Expected Values, QPM Plan
<b>Outputs</b>	Corrective Actions, Process Performance Baseline
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Measurement Data Analysis NOT within Expected Values Implies Corrective Actions Identified Process Performance Baseline Managed & Controlled
<b>Comments</b>	

<b>Name</b>	Maintain Process Capability Baseline
<b>ID</b>	AF-0173
<b>Purpose</b>	To maintain the baseline for the organizations process performance capability.
<b>Correlates to</b>	QP.Ac2, QP.Ac7
<b>Agents</b>	Maintainers
<b>Inputs</b>	Process Capability Baseline, Process Performance Baselines, QPM Plan
<b>Outputs</b>	New Process Capability Baseline
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	New Process Capability Baseline (Documented AND Managed & Controlled)
<b>Comments</b>	Establish is not included as a separate requirement, it is assumed.

<b>Name</b>	Manage Quality
<b>ID</b>	AF-0174
<b>Purpose</b>	To manage quality for the project's software products and take corrective action to ensure the goals are met.
<b>Correlates to</b>	SQ.Ac3, SQ.Ac4
<b>Agents</b>	Monitors
<b>Inputs</b>	Software Work Products, Project Quality Goals, Quality Data Analysis, Software Quality Management Plan
<b>Outputs</b>	Corrective Actions, Status
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Project Quality Goals Implies Corrective Actions Identified
<b>Comments</b>	Related to QAF 6.1.a

<b>Name</b>	Allocate Quality Goals
<b>ID</b>	AF-0175
<b>Purpose</b>	To allocate quality goals to suppliers developing part of the software system.
<b>Correlates to</b>	SQ.Ac5
<b>Agents</b>	Allocators, Suppliers
<b>Inputs</b>	Project Quality Goals, Software Development Plan, Supplier Work Plan
<b>Outputs</b>	Allocated Quality Goals
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Related to AF-0096, Determine Key Supplier Requirements
<b>Comments</b>	

<b>Name</b>	Conduct Task Preparation Meeting
<b>ID</b>	AF-0176
<b>Purpose</b>	To prepare team members for a particular task with the goal of reducing defects.
<b>Correlates to</b>	DP.Ac2
<b>Agents</b>	Team
<b>Inputs</b>	PDSP, Software Development Plan, Quality Goals, Task Methods, Task Tools, Sample Products, Common Defects
<b>Outputs</b>	Defect Prevention Info
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	At ML2, PDSP may not be formalized. Defect Prevention Info is any information, such as explanation of tasks, sample inputs/outputs, or guidance on tools, that may contribute to reducing defects.

<b>Name</b>	Coordinate Prevention Action
<b>ID</b>	AF-0177
<b>Purpose</b>	To coordinate the assignment and implementation of defect prevention actions.
<b>Correlates to</b>	DP.Ac4, DP.Ac6
<b>Agents</b>	DP Team
<b>Inputs</b>	Defects, Software Work Products, Defect Causes, Proposed Actions, Experimental Results
<b>Outputs</b>	OSSP Actions, PDSP Actions, Decision Rationale
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Decision Rationale Documented (OSSP Actions AND PDSP Actions) Assigned
<b>Comments</b>	

<b>Name</b>	Identify Technology Change Areas
<b>ID</b>	AF-0178
<b>Purpose</b>	To identify areas to introduce, update, or change the current technology base.
<b>Correlates to</b>	2.2.a, TC.Ac2
<b>Agents</b>	TCM Group, Project Personnel,
<b>Inputs</b>	Organization Current Technologies, Organization Goals, Project Goals, Organization Requirements, Project Requirements, Leading Technologies
<b>Outputs</b>	Technology Change Requests
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Analyze OSSP
<b>ID</b>	AF-0179
<b>Purpose</b>	To analyze the organization's standard software process and associated technologies to identify changes that would benefit the organization.
<b>Correlates to</b>	TC.Ac4, TC.Ac7
<b>Agents</b>	TCM Group
<b>Inputs</b>	OSSP, Organization Current Technologies, Technology Change Requests
<b>Outputs</b>	Technology Analysis
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Technology Analysis Documented
<b>Comments</b>	Technology Analysis includes proposed changes, expected outcomes, proposed pilots, etc.

<b>Name</b>	Select Technology
<b>ID</b>	AF-0180
<b>Purpose</b>	To select which technology change requests to approve based on the organization's standard software process and technology change plan.
<b>Correlates to</b>	TC.Ac5
<b>Agents</b>	TCM Group, Senior Leaders
<b>Inputs</b>	Technology Change Requests, OSSP, Organization Current Technologies, Selection Criteria, TCM Plan
<b>Outputs</b>	Technology Change Actions, Technology Requirements, Technology Plans
<b>Entrance Criteria</b>	Selection Criteria (Predefined AND Approved)
<b>Exit Criteria</b>	Technology Change Actions, Technology Requirements, Technology Plans)
<b>Comments</b>	Documented AND (Reviewed AND Approved by Senior Leaders)

<b>Name</b>	Acquire Technology
<b>ID</b>	AF-0181
<b>Purpose</b>	To acquire the selected technology based on the actions, requirements and plans.
<b>Correlates to</b>	TC.Ac5
<b>Agents</b>	TCM Group, Senior Leaders
<b>Inputs</b>	Technology Change Actions, Technology Requirements, Technology Plans
<b>Outputs</b>	New Technology
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Conduct Technology Pilot
<b>ID</b>	AF-0182
<b>Purpose</b>	To conduct a pilot with a newly acquired technology to evaluate it before implementing it across the organization.
<b>Correlates to</b>	TC.Ac6
<b>Agents</b>	TCM Group, Technology Users
<b>Inputs</b>	New Technology, Pilot Plan
<b>Outputs</b>	Pilot Analysis, Implementation Decision
<b>Entrance Criteria</b>	Pilot Plan (Reviewed AND Approved by Technology Users)
<b>Exit Criteria</b>	Pilot Analysis Documented
<b>Comments</b>	

<b>Name</b>	Coordinate Process Improvement Activities
<b>ID</b>	AF-0183
<b>Purpose</b>	To coordinate process improvement activities across the organization.
<b>Correlates to</b>	PC.Ac2, PC.Ac4
<b>Agents</b>	SEPG, Organization Members, Senior Leaders
<b>Inputs</b>	Process Improvement Plan
<b>Outputs</b>	Process Improvement Activities
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Review Process Improvement Proposal
<b>ID</b>	AF-0184
<b>Purpose</b>	To approve/disapprove improvement proposals based on capability baselines and goals, and to identify associated actions to implement them.
<b>Correlates to</b>	PC.Ac2, PC.Ac5
<b>Agents</b>	SEPG, Senior Leaders
<b>Inputs</b>	Improvement Proposal, Process Capability Baseline, Organization Improvement Goals, Review Criteria, Review Procedure
<b>Outputs</b>	Process Improvement Actions, Rationale
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Develop Action Plan
<b>ID</b>	AF-0185
<b>Purpose</b>	To develop an action plan based on approved improvement proposals
<b>Correlates to</b>	3.2.a, PF.Ac1, PC.Ac4, PC.Ac6
<b>Agents</b>	Improvement Team, Process Owners,. Senior Leaders
<b>Inputs</b>	Improvement Actions, Software Process Improvement Plan, Improvement Goals
<b>Outputs</b>	Process Improvement Action Plan
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	

<b>Name</b>	Pilot Process Improvement
<b>ID</b>	AF-0186
<b>Purpose</b>	To test new processes in limited use, and evaluate them for transfer to the rest of the organization.
<b>Correlates to</b>	5.1.b, PF.Ac5, PC.Ac4, PC.Ac7
<b>Agents</b>	Evaluators, Process Owners
<b>Inputs</b>	Action Plan, Pilot Process, Acceptance Criteria
<b>Outputs</b>	Approved Process, Actions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Actions address updating OSSP & PDSP, in addition to implementation issues.

<b>Name</b>	Implement Process
<b>ID</b>	AF-0187
<b>Purpose</b>	To implement process improvements in the organization.
<b>Correlates to</b>	2.2.a, 5.1.a, 5.2.b, 5.3.b, 5.4.b, PC.Ac4, PC.Ac8
<b>Agents</b>	Implementors, Process Owners
<b>Inputs</b>	Process, Action Plan, Actions
<b>Outputs</b>	Improved Process
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	
<b>Comments</b>	Closely related to AF-0130 & AF-0131 for PDSP and AF-0191 & AF-0192 for OSSP. This requirement relates to actually using a new process.

<b>Name</b>	Maintain SPI Activity Records
<b>ID</b>	AF-0188
<b>Purpose</b>	To document and maintain records of successful and failed improvement efforts.
<b>Correlates to</b>	PC.Ac4, PC.Ac9
<b>Agents</b>	SEPG
<b>Inputs</b>	Process Improvement Activities, Improvement Results, Improvement Data, Improvement Data Analysis, Improvement Plans
<b>Outputs</b>	Process Improvement Records, Process Improvement Reports
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Process Improvement Records, Process Improvement Reports)
<b>Comments</b>	Available AND Communicated

<b>Name</b>	Release Product
<b>ID</b>	AF-0189
<b>Purpose</b>	To build and release a product to the customer.
<b>Correlates to</b>	CM.Ac2, CM.Ac3, CM.Ac7
<b>Agents</b>	CM Group, SCCB, SW Engineering Group
<b>Inputs</b>	CM Plan, Software Baselines
<b>Outputs</b>	Software Product
<b>Entrance Criteria</b>	SCCB Approval
<b>Exit Criteria</b>	Software Product Built Only from Software Baselines
<b>Comments</b>	

<b>Name</b>	Record SCI Status
<b>ID</b>	AF-0190
<b>Purpose</b>	To document and maintain the status of software configuration items.
<b>Correlates to</b>	CM.Ac2, CM.Ac8, CM.Ac9
<b>Agents</b>	CM Group
<b>Inputs</b>	CM Plan, Software Baselines
<b>Outputs</b>	Status Reports
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Status Reports Available AND Communicated
<b>Comments</b>	

<b>Name</b>	Develop OSSP
<b>ID</b>	AF-0191
<b>Purpose</b>	To develop the organization standard software process.
<b>Correlates to</b>	5.1.a, PF.Co2, PF.Co3, PF.Ac3, PD.Ac1, PD.Ac2
<b>Agents</b>	SEPG, Senior Leaders, Process Owners
<b>Inputs</b>	Software Policies, Process Standards, Product Standards, Customer Standards, Benchmark Processes, Technology
<b>Outputs</b>	OSSP
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	OSSP Documented
<b>Comments</b>	OSSP (Reviewed AND Approved) by (Senior Leaders AND SEPG) OSSP - Organization Standard Software Process Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement. For an organization that has as OSSP, this requirement may refer to developing new processes for the OSSP and the its use by the organization.

<b>Name</b>	Maintain OSSP
<b>ID</b>	AF-0192
<b>Purpose</b>	To maintain the organization standard software process.
<b>Correlates to</b>	5.1.a, PF.Co2, PF.Co3, PF.Ac3, PD.Ac1, PD.Ac2, DP.Ac6, TC.Ac7
<b>Agents</b>	SEPG, Senior Leaders, Process Owners
<b>Inputs</b>	OSSP Change Actions, Software Policies, Process Standards, Product Standards, Customer Standards, Benchmark Processes, Technology
<b>Outputs</b>	OSSP
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	OSSP Documented
<b>Comments</b>	OSSP (Reviewed AND Approved) by (Senior Leaders AND SEPG) OSSP - Organization Standard Software Process Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement. OSSP Change Actions may come from Defect Prevention Analysis. OSSP Change Actions may come from technology changes associated with the Technology input.

<b>Name</b>	Develop Software LifeCycle Description
<b>ID</b>	AF-0193
<b>Purpose</b>	To develop descriptions of the approved software lifecycles.
<b>Correlates to</b>	PP.Ac5, PF.Co2, PF.Co3, PD.Ac3
<b>Agents</b>	SEPG, Senior Leaders, Process Owners
<b>Inputs</b>	Software Lifecycles, Documentation Standards
<b>Outputs</b>	Software LifeCycle Descriptions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software LifeCycle Descriptions Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
<b>Comments</b>	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement.

<b>Name</b>	Develop Tailoring Guidelines
<b>ID</b>	AF-0194
<b>Purpose</b>	To develop guidelines for tailoring the organization standard software process for use on a project.
<b>Correlates to</b>	PF.Co2, PF.Co3, PD.Ac4
<b>Agents</b>	SEPG, Senior Leaders, Process Owners
<b>Inputs</b>	OSSP, Software LifeCycle Descriptions, Documentation Standards
<b>Outputs</b>	Tailoring Guidelines
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Tailoring Guidelines Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
<b>Comments</b>	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement.

<b>Name</b>	Maintain Tailoring Guidelines
<b>ID</b>	AF-0195
<b>Purpose</b>	To maintain guidelines for tailoring the organization standard software process for use on a project.
<b>Correlates to</b>	PF.Co2, PF.Co3, PD.Ac4
<b>Agents</b>	SEPG, Senior Leaders, Process Owners
<b>Inputs</b>	Change Actions, OSSP, Software LifeCycle Descriptions, Documentation Standards
<b>Outputs</b>	Tailoring Guidelines
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Tailoring Guidelines Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
<b>Comments</b>	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement.

<b>Name</b>	Maintain Software LifeCycle Description
<b>ID</b>	AF-0196
<b>Purpose</b>	To maintain descriptions of the approved software lifecycles.
<b>Correlates to</b>	PP.Ac5, PF.Co2, PF.Co3, PD.Ac3
<b>Agents</b>	SEPG, Senior Leaders, Process Owners
<b>Inputs</b>	Software Lifecycles, Change Actions, Documentation Standards
<b>Outputs</b>	Software LifeCycle Descriptions
<b>Entrance Criteria</b>	
<b>Exit Criteria</b>	Software LifeCycle Descriptions Documented (Reviewed AND Approved) by (Senior Leaders AND SEPG)
<b>Comments</b>	Senior Leaders are input to meet the Organization Process Focus Commitment 2 & 3. These state that senior leaders sponsor and oversee the organization's activities for software process development and improvement.

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## *Appendix B - Capability Maturity Model Relations to Quality Air Force and Integrated Requirements*

### *1.0 Purpose*

The overall purpose of this document is to reference the Capability Maturity Model for Software (CMM) to the Quality Air Force (QAF) criteria by identifying the integrated requirements that relate the two models.

### *2.0 Overview*

This document maps the CMM to the QAF criteria through the integrated requirements that correlate back to each model. Only the CMM practices that have a relationship to QAF areas are included. The document is organized to mirror the maturity levels and key process areas in the CMM. The related area of the QAF criteria is provided along with the name and ID of the integrated requirement that correlates to that CMM practice and the identified QAF areas.

### **3.0 Guide to Codes**

#### **3.1 Capability Maturity Model Codes.**

##### **3.1.1 Key Process Areas (KPA's):**

RM	Requirements Management
PP	Software Project Planning
PT	Software Project Tracking & Oversight
SM	Software Subcontract Management
QA	Software Quality Assurance
CM	Software Configuration Management
PF	Organization Process Focus
PD	Organization Process Definition
TP	Training Program
IM	Integrated Software Management
PE	Software Product Engineering
IC	InterGroup Coordination
PR	Peer Reviews
QP	Quantitative Process Management
SQ	Software Quality Management
DP	Defect Prevention
TC	Technology Change Management
PC	Process Change Management

##### **3.1.2 Other Common Features (OCFs):**

Co	Commitment to Perform
Ab	Ability to Perform
Me	Measurement and Analysis
Ve	Verifying Implementation

### *3.2 Quality Air Force Criteria Codes*

- 1.0 Leadership
  - 1.1 Senior Executive Leadership
  - 1.2 Leadership System and Organization
  - 1.3 Public Responsibility and Citizenship
- 2.0 Information and Analysis
  - 2.1 Management of Information and Data
  - 2.2 Comparisons and Benchmarking
  - 2.3 Analysis and Use of Organization-Level Data
- 3.0 Strategic Planning
  - 3.1 Strategy Development
  - 3.2 Strategic Deployment
- 4.0 Human Resource Development and Management
  - 4.1 Human Resource Planning and Evaluation
  - 4.2 High Performance Work Systems
  - 4.3 Member Education, Training, and Development
  - 4.4 Well Being and Satisfaction
- 5.0 Process Management
  - 5.1 Design and Introduction of Products and Services
  - 5.2 Key Process Management: Product and Service Production and Delivery
  - 5.3 Process Management: Support Services
  - 5.4 Supplier Performance Management
- 6.0 Performance Results
  - 6.1 Product and Service Quality
  - 6.2 Operational Performance and Financial Results
  - 6.3 Supplier Performance Results

## 7.0 Customer Focus and Customer Satisfaction

### 7.1 Customer Knowledge

### 7.2 Customer Management

### 7.3 Customer Satisfaction Determination

### 7.4 Customer Satisfaction Results

### 7.5 Customer Satisfaction Comparison

#### 4.0 Reference

CMM	Related to QAF	Related By	ID
Me	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
Me	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
Ve	1.2.c	Review Project (Event Driven)	AF-0109
Ve	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
Ve	1.2.c, 5.4.a	Review Project (Periodic)	AF-0148
Ve	1.1.b, 2.1.b, 2.2.b, 3.1.c, 4.1.b, 5.1.c, 5.2.b, 5.3.c, 5.4.b, 7.1.c, 7.2.d, 7.3.c	Evaluate Process	AF-0070
PP.Ac2	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac3	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac4	1.2.c, 5.4.a	Project Review	AF-0148
PP.Ac5	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac6	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac7	3.1.b	Set Objectives	AF-0014
PP.Ac7	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac14	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PP.Ac15	2.3.a, 6.1.a, 6.2.a	Gather Internal Data	AF-0098
PT.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PT.Ac2	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
PT.Ac4	5.4.b	Change Supplier Commitment	AF-0113
PT.Ac5	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac6	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac7	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac8	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac9	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac10	5.2.a, 5.3.b	Take Corrective Actions	AF-0116
PT.Ac11	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PT.Ac11	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
PT.Ac12	1.2.c, 5.4.a	Project Review	AF-0148
PT.Ac13	1.2.c, 5.4.a	Project Review	AF-0148

SM.Ac1	5.4.b	Determine Partnering Activities	AF-0085
SM.Ac1	5.4.a	Determine Key Supplier Requirements	AF-0096
SM.Ac1	5.4.b	Plan Supplier Work	AF-0119
SM.Ac2	1.1.a, 1.2.c	Process Assessment	AF-0080
SM.Ac2	7.1.a	Select Group	AF-0100
SM.Ac3	5.4.a	Communicate Supplier Reqs	AF-0095
SM.Ac4	5.1.b	Review Product	AF-0108
SM.Ac6	5.4.b	Change Supplier Commitment	AF-0113
SM.Ac7	1.2.c, 5.4.a	Project Review	AF-0148
SM.Ac9	1.2.c, 5.4.a	Project Review	AF-0148
SM.Ac12	5.4.a	Perform Supplier Acceptance Tests	AF-0064
SM.Ac13	1.1.b, 2.1.b, 2.2.b, 3.1.c, 4.1.b, 5.1.c, 5.2.b, 5.3.c, 5.4.b, 7.1.c, 7.2.d, 7.3.c	Evaluate Process	AF-0070
QA.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
QA.Ac2	5.4.a, 7.2.a	Communicate Information	AF-0097
QA.Ac2	5.1.b	Review Product	AF-0108
QA.Ac3	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
QA.Ac5	5.1.b	Review Product	AF-0108
QA.Ac6	5.4.a, 7.2.a	Communicate Information	AF-0097
QA.Ac7	5.1.b	Review Product	AF-0108
QA.Ac8	5.4.a, 7.2.a	Communicate Information	AF-0097
CM.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
CM.Ac2	5.4.a, 7.2.a	Communicate Information	AF-0097
CM.Ac9	5.4.a, 7.2.a	Communicate Information	AF-0097
PF.Co2	5.1.a	Develop OSSP	AF-0191
PF.Co2	5.1.a	Maintain OSSP	AF-0192
PF.Co3	5.1.a	Develop OSSP	AF-0191
PF.Co3	5.1.a	Maintain OSSP	AF-0192
PF.Ac1	1.1.a, 1.2.c	Process Assessment	AF-0080
PF.Ac1	3.2.a	Develop Action Plan	AF-0185
PF.Ac2	3.1.a, 4.1.a	Strategic Planning	AF-0075
PF.Ac3	5.1.a	Develop OSSP	AF-0191
PF.Ac3	5.1.a	Maintain OSSP	AF-0192
PF.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PF.Ac4	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
PF.Ac5	5.1.b	Pilot Process Improvement	AF-0186
PF.Ac6	4.3.b	Plan Training Delivery	AF-0088
PF.Ac7	5.4.a, 7.2.a	Communicate Information	AF-0097

PD.Ac1	5.1.a	Design Process	AF-0038
PD.Ac1	5.1.a	Develop OSSP	AF-0191
PD.Ac1	5.1.a	Maintain OSSP	AF-0192
PD.Ac2	5.1.a	Design Process	AF-0038
PD.Ac2	5.1.a	Develop OSSP	AF-0191
PD.Ac2	5.1.a	Maintain OSSP	AF-0192
PD.Ac5	2.3.a, 6.1.a, 6.2.a	Gather Internal Data	AF-0098
TP.Ac1	4.3.b	Plan Training Delivery	AF-0088
TP.Ac1	4.3.b	Identify Training Needs	AF-0089
TP.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
TP.Ac2	3.1.a, 4.1.a	Strategic Planning	AF-0075
TP.Ac2	4.3.b	Plan Training Delivery	AF-0088
TP.Ac3	4.3.b	Perform Training	AF-0124
TP.Ac4	4.3.b	Develop Training Course	AF-0125
TP.Me2	4.3.a, 4.3.b	Measure Training Quality	AF-0128
TP.Ve2	4.3.a, 4.3.b	Independent Training Evaluation	AF-0129
TP.Ve3	4.3.a, 4.3.b	Evaluate Training	AF-0018
IM.Ac3	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IM.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
IM.Ac4	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IM.Ac4	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
IM.Ac5	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
IM.Ac5	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IM.Ac5	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
IM.Ac11	1.2.c	Review Project (Event Driven)	AF-0109
IM.Ac11	1.1.b, 2.1.b, 2.2.b, 3.1.c, 4.1.b, 5.1.c, 5.2.b, 5.3.c, 5.4.b, 7.1.c, 7.2.d, 7.3.c	Evaluate Process	AF-0070
IM.Ac11	1.2.c, 5.4.a	Project Review	AF-0148
PE.Ac3	4.3.b, 5.1.a, 5.3.a	Develop Design Criteria	AF-0153
PE.Ac3	5.1.a	Develop Software Arch Design	AF-0154
PE.Ac3	5.1.a	Develop Software Detail Design	AF-0155
PE.Ac9	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PE.Ac9	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
PE.Me1	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PE.Me1	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118

IC.Ac1	7.1.a	Establish System Requirements	AF-0166
IC.Ac3	5.4.a	Communicate Supplier Requirements	AF-0095
IC.Ac3	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IC.Ac4	5.4.a	Determine Key Supplier Requirements	AF-0096
IC.Ac4	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
IC.Ac5	5.1.b	Review Product	AF-0108
PR.Ac2	5.1.b	Review Product	AF-0108
PR.Ac3	5.1.b	Review Product	AF-0108
QP.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
QP.Ac1	2.2.a	Set Performance Objectives	AF-0074
QP.Ac2	2.2.a	Set Performance Objectives	AF-0074
QP.Ac2	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
QP.Ac2	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
QP.Ac2	5.4.a, 7.2.a	Communicate Information	AF-0097
QP.Ac3	2.1.a, 2.2.a, 5.4.a, 7.1.a	Determine Indicators	AF-0071
QP.Ac4	2.1.a, 2.2.a, 5.4.a, 7.1.a	Determine Indicators	AF-0071
QP.Ac4	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
QP.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
QP.Ac4	2.2.a	Set Performance Objectives	AF-0074
QP.Ac6	5.4.a, 7.2.a	Communicate Information	AF-0097
SQ.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
SQ.Ac2	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
SQ.Ac2	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
SQ.Ac3	2.2.a	Set Performance Objectives	AF-0074
SQ.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
SQ.Ac4	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
DP.Ac1	5.1.a, 5.2.a, 5.3.b	Project Planning	AF-0114
DP.Ac3	5.2.a, 5.3.b	Determine Root Cause	AF-0043
DP.Ac5	5.2.a, 5.3.b	Determine Root Cause	AF-0043
DP.Ac5	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
DP.Ac5	5.4.a, 6.1.a, 6.3.a	Measure Product	AF-0118
DP.Ac6	5.1.a	Maintain OSSP	AF-0192
DP.Ac8	5.4.a, 7.2.a	Communicate Information	AF-0097

TC.Ac1	3.1.a, 4.1.a	Strategic Planning	AF-0075
TC.Ac2	2.2.a	Identify Technology Change Areas	AF-0178
TC.Ac3	5.4.a, 7.2.a	Communicate Information	AF-0097
TC.Ac7	5.1.a	Maintain OSSP	AF-0192
PC.Ac2	1.1.a	Set Goals	AF-0019
PC.Ac3	3.1.a, 4.1.a	Strategic Planning	AF-0075
PC.Ac4	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
PC.Ac4	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PC.Ac4	1.1.a	Set Goals	AF-0019
PC.Ac4	5.4.a, 7.2.a	Communicate Information	AF-0097
PC.Ac4	3.2.a	Develop Action Plan	AF-0185
PC.Ac4	5.1.b	Pilot Process Improvement	AF-0186
PC.Ac4	2.2.a, 5.1.a, 5.2.b, 5.3.b, 5.4.b	Implement Process	AF-0187
PC.Ac6	3.2.a	Develop Action Plan	AF-0185
PC.Ac7	5.1.b	Pilot Process Improvement	AF-0186
PC.Ac8	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
PC.Ac8	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073
PC.Ac8	2.2.a, 5.1.a, 5.2.b, 5.3.b, 5.4.b	Implement Process	AF-0187
PC.Ac10	5.4.a, 7.2.a	Communicate Information	AF-0097
PC.Me1	1.1.a, 5.2.a, 5.3.b, 5.4.a, 6.2.a, 6.3.a	Measure Process	AF-0072
PC.Me1	1.1.a, 2.2.a, 2.3.a, 3.2.b, 5.2.a, 5.3.b, 5.4.a, 6.1.a, 6.2.a, 6.3.a, 7.2.b, 7.2.c, 7.3.a, 7.3.b, 7.4.a, 7.4.b, 7.5.a, 7.5.b	Analyze Data	AF-0073

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## *Appendix C - Quality Air Force Relations to Capability Maturity Model and Integrated Requirements*

### *1.0 Purpose*

The overall purpose of this document is to reference the Quality Air Force (QAF) criteria to the Capability Maturity Model for Software (CMM) by identifying the integrated requirements that relate the two models.

### *2.0 Overview*

This document maps the QAF criteria to the CMM through the integrated requirements that correlate back to each model. Only the QAF criteria areas that have a relationship to CMM practices are included. The document is organized to mirror the categories, areas to address, and items in the QAF criteria. The related area of the CMM is provided along with the name and ID of the integrated requirement that correlates to that QAF area and the identified CMM practices.

### *3.0 Guide to Codes*

#### *3.1 Capability Maturity Model Codes.*

##### **3.1.1 Key Process Areas (KPA's):**

RM	Requirements Management
PP	Software Project Planning
PT	Software Project Tracking & Oversight
SM	Software Subcontract Management
QA	Software Quality Assurance
CM	Software Configuration Management
PF	Organization Process Focus
PD	Organization Process Definition
TP	Training Program
IM	Integrated Software Management
PE	Software Product Engineering
IC	InterGroup Coordination
PR	Peer Reviews
QP	Quantitative Process Management
SQ	Software Quality Management
DP	Defect Prevention
TC	Technology Change Management
PC	Process Change Management

##### **3.1.2 Other Common Features (OCFs):**

Co	Commitment to Perform
Ab	Ability to Perform
Me	Measurement and Analysis
Ve	Verifying Implementation

### *3.2 Quality Air Force Criteria Codes*

#### 1.0 Leadership

##### 1.1 Senior Executive Leadership

##### 1.2 Leadership System and Organization

##### 1.3 Public Responsibility and Citizenship

#### 2.0 Information and Analysis

##### 2.1 Management of Information and Data

##### 2.2 Comparisons and Benchmarking

##### 2.3 Analysis and Use of Organization-Level Data

#### 3.0 Strategic Planning

##### 3.1 Strategy Development

##### 3.2 Strategic Deployment

#### 4.0 Human Resource Development and Management

##### 4.1 Human Resource Planning and Evaluation

##### 4.2 High Performance Work Systems

##### 4.3 Member Education, Training, and Development

##### 4.4 Well Being and Satisfaction

#### 5.0 Process Management

##### 5.1 Design and Introduction of Products and Services

##### 5.2 Key Process Management: Product and Service Production and Delivery

##### 5.3 Process Management: Support Services

##### 5.4 Supplier Performance Management

#### 6.0 Performance Results

##### 6.1 Product and Service Quality

##### 6.2 Operational Performance and Financial Results

##### 6.3 Supplier Performance Results

## 7.0 Customer Focus and Customer Satisfaction

### 7.1 Customer Knowledge

### 7.2 Customer Management

### 7.3 Customer Satisfaction Determination

### 7.4 Customer Satisfaction Results

### 7.5 Customer Satisfaction Comparison

#### 4.0 Reference

QAF	Related to CMM	Related By	ID
1.1.a	PC.Ac2, PC.Ac4	Set Goals	AF-0019
1.1.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
1.1.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
1.1.a	SM.Ac2, PF.Ac1	Process Assessment	AF-0080
1.1.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
1.2.c	SM.Ac2, PF.Ac1	Process Assessment	AF-0080
1.2.c	IM.Ac11, Ve	Review Project (Event Driven)	AF-0109
1.2.c	PP.Ac4, PT.Ac12, PT.Ac13, SM.Ac7, SM.Ac9, IM.Ac11, Ve	Review Project (Periodic)	AF-0148
2.1.a	QP.Ac3, QP.Ac4	Determine Indicators	AF-0071
2.1.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
2.2.a	QP.Ac3, QP.Ac4	Determine Indicators	AF-0071
2.2.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
2.2.a	SQ.Ac3, QP.Ac1, QP.Ac2, QP.Ac4	Set Performance Objectives	AF-0074
2.2.a	TC.Ac2	Identify Technology Change Areas	AF-0178
2.2.a	PC.Ac4, PC.Ac8	Implement Process	AF-0187
2.2.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
2.3.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
2.3.a	PP.Ac15, PD.Ac5	Gather Internal Data	AF-0098
3.1.a	PF.Ac2, TP.Ac2, TC.Ac1, PC.Ac3	Strategic Planning	AF-0075
3.1.b	PP.Ac7	Set Objectives	AF-0014
3.1.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
3.2.a	PF.Ac1, PC.Ac4, PC.Ac6	Develop Action Plan	AF-0185
3.2.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
4.1.a	PF.Ac2, TP.Ac2, TC.Ac1, PC.Ac3	Strategic Planning	AF-0075
4.1.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070

4.3.a	TP.Ve3	Evaluate Training	AF-0018
4.3.a	TP.Me2	Measure Training Quality	AF-0128
4.3.a	TP.Ve2	Independent Training Evaluation	AF-0129
4.3.b	TP.Ve3	Evaluate Training	AF-0018
4.3.b	PF.Ac6, TP.Ac1, TP.Ac2	Plan Training Delivery	AF-0088
4.3.b	TP.Ac1	Identify Training Needs	AF-0089
4.3.b	TP.Ac3	Perform Training	AF-0124
4.3.b	TP.Ac4	Develop Training Course	AF-0125
4.3.b	TP.Me2	Measure Training Quality	AF-0128
4.3.b	TP.Ve2	Independent Training Evaluation	AF-0129
4.3.b	PE.Ac3	Develop Design Criteria	AF-0153
5.1.a	PD.Ac1, PD.Ac2	Design Process	AF-0038
5.1.a	PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1	Project Planning	AF-0114
5.1.a	PE.Ac3	Develop Design Criteria	AF-0153
5.1.a	PE.Ac3	Develop Software Architecture Design	AF-0154
5.1.a	PE.Ac3	Develop Software Detail Design	AF-0155
5.1.a	PC.Ac4, PC.Ac8	Implement Process	AF-0187
5.1.a	PF.Co2, PF.Co3, PF.Ac3, PD.Ac1, PD.Ac2	Develop OSSP	AF-0191
5.1.a	PF.Co2, PF.Co3, PF.Ac3, PD.Ac1, PD.Ac2, DP.Ac6, TC.Ac7	Maintain OSSP	AF-0192
5.1.b	SM.Ac4, QA.Ac2, QA.Ac5, QA.Ac7, IC.Ac5, PR.Ac2, PR.Ac3	Review Product	AF-0108
5.1.b	PF.Ac5, PC.Ac4, PC.Ac7	Pilot Process Improvement	AF-0186
5.1.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
5.2.a	DP.Ac3, DP.Ac5	Determine Root Cause	AF-0043
5.2.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
5.2.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
5.2.a	PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1	Project Planning	AF-0114
5.2.a	PT.Ac5, PT.Ac6, PT.Ac7, PT.Ac8, PT.Ac9, PT.Ac10, Ve	Take Corrective Actions	AF-0116

5.2.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
5.2.b	PC.Ac4, PC.Ac8	Implement Process	AF-0187
5.3.a	PE.Ac3	Develop Design Criteria	AF-0153
5.3.b	DP.Ac3, DP.Ac5	Determine Root Cause	AF-0043
5.3.b	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
5.3.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
5.3.b	PP.Ac2, PP.Ac3, PP.Ac5, PP.Ac6, PP.Ac7, PP.Ac14, PT.Ac1, PT.Ac2, QA.Ac1, QA.Ac3, CM.Ac1, TP.Ac1, IM.Ac3, IM.Ac4, IM.Ac5, IC.Ac3, IC.Ac4, QP.Ac1, SQ.Ac1, DP.Ac1	Project Planning	AF-0114
5.3.b	PT.Ac5, PT.Ac6, PT.Ac7, PT.Ac8, PT.Ac9, PT.Ac10, Ve	Take Corrective Actions	AF-0116
5.3.b	PC.Ac4, PC.Ac8	Implement Process	AF-0187
5.3.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
5.4.a	SM.Ac12	Perform Supplier Acceptance Test	AF-0064
5.4.a	QP.Ac3, QP.Ac4	Determine Indicators	AF-0071
5.4.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
5.4.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
5.4.a	SM.Ac3, IC.Ac3	Communicate Supplier Requirements	AF-0095
5.4.a	SM.Ac1, IC.Ac4	Determine Key Supplier Requirements	AF-0096
5.4.a	QA.Ac2, QA.Ac6, QA.Ac8, CM.Ac2, CM.Ac9, PF.Ac7, QP.Ac2, QP.Ac6, DP.Ac8, TC.Ac3, PC.Ac4, PC.Ac10	Communicate Information	AF-0097
5.4.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, SQ.Ac2, SQ.Ac4, DP.Ac5	Measure Product	AF-0118
5.4.a	PP.Ac4, PT.Ac12, PT.Ac13, SM.Ac7, SM.Ac9, IM.Ac11, Ve	Review Project (Periodic)	AF-0148

5.4.b	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
5.4.b	SM.Ac1	Determine Partnering Activities	AF-0085
5.4.b	PT.Ac4, SM.Ac6	Change Supplier Commitment	AF-0113
5.4.b	SM.Ac1	Plan Supplier Work	AF-0119
5.4.b	PC.Ac4, PC.Ac8	Implement Process	AF-0187
6.1.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
6.1.a	PP.Ac15, PD.Ac5	Gather Internal Data	AF-0098
6.1.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, SQ.Ac2, SQ.Ac4, DP.Ac5	Measure Product	AF-0118
6.2.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
6.2.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
6.2.a	PP.Ac15, PD.Ac5	Gather Internal Data	AF-0098
6.3.a	QP.Ac2, QP.Ac4, PC.Ac8, PC.Me1, Me	Measure Process	AF-0072
6.3.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
6.3.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, SQ.Ac2, SQ.Ac4, DP.Ac5	Measure Product	AF-0118
7.1.a	QP.Ac3, QP.Ac4	Determine Indicators	AF-0071
7.1.a	SM.Ac2	Select Group	AF-0100
7.1.a	IC.Ac1	Establish System Requirements	AF-0166
7.1.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
7.2.a	QA.Ac2, QA.Ac6, QA.Ac8, CM.Ac2, CM.Ac9, PF.Ac7, QP.Ac2, QP.Ac6, DP.Ac8, TC.Ac3, PC.Ac4, PC.Ac10	Communicate Information	AF-0097
7.2.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.2.c	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.2.d	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070

7.3.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.3.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.3.c	SM.Ac13, IM.Ac11, Ve	Evaluate Process	AF-0070
7.4.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.4.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.5.a	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073
7.5.b	PT.Ac11, PF.Ac4, IM.Ac4, IM.Ac5, PE.Ac9, PE.Me1, QP.Ac2, QP.Ac4, SQ.Ac2, SQ.Ac4, DP.Ac5, PC.Ac8, PC.Me1, Me	Analyze Data	AF-0073

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## *Appendix D - Capability Maturity Model Map to Integrated Requirements*

### *1.0 Purpose*

The overall purpose of this document is to reference the Capability Maturity Model for Software (CMM) to the integrated requirements.

### *2.0 Overview*

This document maps the CMM to the integrated requirements. All CMM practices are included. The document is organized to mirror the maturity levels and key process areas of the CMM.

### *3.0 Guide to Codes*

#### *3.1 Key Process Areas (KPA's):*

RM	Requirements Management
PP	Software Project Planning
PT	Software Project Tracking & Oversight
SM	Software Subcontract Management
QA	Software Quality Assurance
CM	Software Configuration Management
PF	Organization Process Focus
PD	Organization Process Definition
TP	Training Program
IM	Integrated Software Management
PE	Software Product Engineering
IC	InterGroup Coordination
PR	Peer Reviews
QP	Quantitative Process Management
SQ	Software Quality Management
DP	Defect Prevention
TC	Technology Change Management
PC	Process Change Management

### ***3.2 Other Common Features (OCFs):***

Co	Commitment to Perform
Ab	Ability to Perform
Me	Measurement and Analysis
Ve	Verifying Implementation

Activity	Name	ID
	<b>Other Common Features</b>	
<b>Ab</b>	Adequate Resources	AF-0055
	Adequate Funding	AF-0056
	Adequate Training	AF-0057
<b>Co</b>	Follows Policy	AF-0054
	Follows Procedure	AF-0058
<b>Me</b>	Determine Status	AF-0059
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Measure Activity	AF-0110
<b>Ve</b>	Evaluate Process	AF-0070
	Event Driven Review	AF-0109
	Take Corrective Actions	AF-0116
	Project Review	AF-0148
	<b>Requirements Management</b>	
<b>RM.Ab1</b>	Allocate Requirements	AF-0060
<b>RM.Ab2</b>	Allocate Requirements	AF-0060
<b>RM.Ac1</b>	Negotiate Commitments	AF-0111
	Review Allocated Requirements	AF-0149
	Correct Allocated Requirements	AF-0150
<b>RM.Ac2</b>	Develop Software Requirements	AF-0112
<b>RM.Ac3</b>	Assess Requirements Change	AF-0061
	Make Commitment	AF-0115
	Review Allocated Requirements	AF-0149
	<b>Software Project Planning</b>	
<b>PP.Ac1</b>	Develop Project Proposal	AF-0063
<b>PP.Ac2</b>	Project Planning	AF-0114
<b>PP.Ac3</b>	Project Planning	AF-0114
<b>PP.Ac4</b>	Make Commitment	AF-0115
	Project Review	AF-0148
<b>PP.Ac5</b>	Project Planning	AF-0114
	Develop Software LifeCycle Descriptions	AF-0193
	Maintain Software LifeCycle Descriptions	AF-0196
<b>PP.Ac6</b>	Project Planning	AF-0114
<b>PP.Ac7</b>	Set Objectives	AF-0014
	Project Planning	AF-0114
<b>PP.Ac8</b>	Identify Software Work Products	AF-0132
<b>PP.Ac9</b>	Estimate Size	AF-0133
<b>PP.Ac10</b>	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
<b>PP.Ac11</b>	Estimate Critical Computer Resources	AF-0136
<b>PP.Ac12</b>	Derive Schedule	AF-0137

<b>PP.Ac13</b>	Risk Identification	AF-0138
	Risk Analysis	AF-0139
	Risk Prioritization	AF-0140
<b>PP.Ac14</b>	Project Planning	AF-0114
<b>PP.Ac15</b>	Gather Internal Data	AF-0098
	Estimate Size	AF-0133
	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Estimate Critical Computer Resources	AF-0136
	Derive Schedule	AF-0137
	Risk Identification	AF-0138
	<b>Software Project Tracking &amp; Oversight</b>	
<b>PT.Ac1</b>	Project Planning	AF-0114
<b>PT.Ac2</b>	Project Planning	AF-0114
<b>PT.Ac3</b>	Make Commitment	AF-0115
<b>PT.Ac4</b>	Change Supplier Commitment	AF-0113
<b>PT.Ac5</b>	Take Corrective Actions	AF-0116
	Manage Size	AF-0141
<b>PT.Ac6</b>	Take Corrective Actions	AF-0116
	Manage Effort	AF-0142
	Manage Cost	AF-0143
<b>PT.Ac7</b>	Take Corrective Actions	AF-0116
	Manage Critical Computer Resources	AF-0144
<b>PT.Ac8</b>	Take Corrective Actions	AF-0116
	Manage Schedule	AF-0169
<b>PT.Ac9</b>	Take Corrective Actions	AF-0116
	Track Technical Activities	AF-0117
<b>PT.Ac10</b>	Take Corrective Actions	AF-0116
	Manage Risks	AF-0147
<b>PT.Ac11</b>	Analyze Data	AF-0073
	Measure Product	AF-0118
	Measure Activity	AF-0110
<b>PT.Ac12</b>	Project Review	AF-0148
<b>PT.Ac13</b>	Project Review	AF-0148
	<b>Software Subcontract Management</b>	
<b>SM.Ac1</b>	Determine Partnering Activities	AF-0085
	Determine Key Supplier Requirements	AF-0096
	Plan Supplier Work	AF-0119
<b>SM.Ac2</b>	Process Assessment	AF-0080
	Select Group	AF-0100
<b>SM.Ac3</b>	Make Contractual Agreement	AF-0062
	Communicate Supplier Requirements	AF-0095
<b>SM.Ac4</b>	Review Product	AF-0108
<b>SM.Ac5</b>	Activity Review	AF-0120
<b>SM.Ac6</b>	Change Supplier Commitment	AF-0113

SM.Ac7	Project Review	AF-0148
SM.Ac8	Activity Review	AF-0120
SM.Ac9	Project Review	AF-0148
SM.Ac10	Activity Review	AF-0120
SM.Ac11	Activity Review	AF-0120
SM.Ac12	Perform Supplier Acceptance Tests	AF-0064
SM.Ac13	Evaluate Process	AF-0070
	<b>Software Quality Assurance</b>	
QA.Ac1	Project Planning	AF-0114
QA.Ac2	Activity Review	AF-0120
	Communicate Information	AF-0097
	Handle Deviations	AF-0065
	Review Product	AF-0108
QA.Ac3	Project Planning	AF-0114
	Develop PDSP	AF-0130
	Revise PDSP	AF-0131
QA.Ac4	Activity Review	AF-0120
QA.Ac5	Review Product	AF-0108
QA.Ac6	Communicate Information	AF-0097
QA.Ac7	Handle Deviations	AF-0065
	Review Product	AF-0108
QA.Ac8	Communicate Information	AF-0097
	<b>Software Configuration Management</b>	
CM.Ac1	Project Planning	AF-0114
CM.Ac2	Establish CM Library System	AF-0066
	Identify Software Configuration Items	AF-0067
	Identify Software Work Products	AF-0132
	Handle Change Requests	AF-0068
	Change Baseline	AF-0069
	Communicate Information	AF-0097
	Record SCI Status	AF-0190
	Audit Baseline	AF-0121
	Release Product	AF-0189
CM.Ac3	Release Product	AF-0189
	Establish CM Library System	AF-0066
CM.Ac4	Identify Software Configuration Items	AF-0067
	Identify Software Work Products	AF-0132
CM.Ac5	Handle Change Requests	AF-0068
CM.Ac6	Change Baseline	AF-0069
CM.Ac7	Release Product	AF-0189
CM.Ac8	Record SCI Status	AF-0190
CM.Ac9	Record SCI Status	AF-0190
	Communicate Information	AF-0097
CM.Ac10	Audit Baseline	AF-0121
CM.Ve3	Audit Baseline	AF-0121

	Organization Process Focus	
<b>PF.Co2</b>	Develop Software LifeCycle Descriptions	AF-0193
	Maintain Software LifeCycle Descriptions	AF-0196
	Develop Tailoring Guidelines	AF-0194
	Maintain Tailoring Guidelines	AF-0195
<b>PF.Co3</b>	Develop Software LifeCycle Descriptions	AF-0193
	Maintain Software LifeCycle Descriptions	AF-0196
	Develop Tailoring Guidelines	AF-0194
	Maintain Tailoring Guidelines	AF-0195
<b>PF.Ac1</b>	Process Assessment	AF-0080
	Develop Action Plan	AF-0185
<b>PF.Ac2</b>	Strategic Planning	AF-0075
<b>PF.Ac3</b>	Develop PDSP	AF-0130
	Revise PDSP	AF-0131
<b>PF.Ac4</b>	Analyze Data	AF-0073
	Estimate Size	AF-0133
	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Estimate Critical Computer Resources	AF-0136
	Derive Schedule	AF-0137
	Maintain Software Process Database	AF-0111
	Measure Product	AF-0118
<b>PF.Ac5</b>	Pilot Process Improvement	AF-0186
<b>PF.Ac6</b>	Plan Training Delivery	AF-0088
<b>PF.Ac7</b>	Communicate Information	AF-0097
	Organization Process Definition	
<b>PD.Ac1</b>	Maintain OSSP	AF-0192
	Develop OSSP	AF-0191
	Design Process	AF-0038
<b>PD.Ac2</b>	Maintain OSSP	AF-0192
	Develop OSSP	AF-0191
	Design Process	AF-0038
<b>PD.Ac3</b>	Develop Software LifeCycle Descriptions	AF-0193
	Maintain Software LifeCycle Descriptions	AF-0196
<b>PD.Ac4</b>	Develop Tailoring Guidelines	AF-0194
	Maintain Tailoring Guidelines	AF-0195
<b>PD.Ac5</b>	Gather Internal Data	AF-0098
	Maintain Software Process Database	AF-0111
<b>PD.Ac6</b>	Maintain Software Process Library	AF-0123
	Training Program	
<b>TP.Ac1</b>	Plan Training Delivery	AF-0088
	Identify Training Needs	AF-0089
	Project Planning	AF-0114
<b>TP.Ac2</b>	Strategic Planning	AF-0075
	Plan Training Delivery	AF-0088

<b>TP.Ac3</b>	Perform Training	AF-0124
<b>TP.Ac4</b>	Develop Training Course	AF-0125
	Maintain Training Course	AF-0126
<b>TP.Ac5</b>	Conduct Training Waiver Procedure	AF-0127
<b>TP.Ac6</b>	Maintain Training Records	AF-0122
<b>TP.Me2</b>	Measure Training Quality	AF-0128
<b>TP.Ve2</b>	Independent Training Evaluation	AF-0129
<b>TP.Ve3</b>	Evaluate Training	AF-0018
	<b>Integrated Software Management</b>	
<b>IM.Ac1</b>	Develop PDSP	AF-0130
<b>IM.Ac2</b>	Revise PDSP	AF-0131
<b>IM.Ac3</b>	Project Planning	AF-0114
<b>IM.Ac4</b>	Analyze Data	AF-0073
	Measure Product	AF-0118
	Project Planning	AF-0114
	Identify Software Work Products	AF-0132
	Estimate Size	AF-0133
	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Estimate Critical Computer Resources	AF-0136
	Derive Schedule	AF-0137
	Risk Identification	AF-0138
	Risk Analysis	AF-0139
	Risk Prioritization	AF-0140
	Manage Critical Paths	AF-0145
<b>IM.Ac5</b>	Analyze Data	AF-0073
	Project Planning	AF-0114
	Measure Product	AF-0118
	Estimate Size	AF-0133
	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Estimate Critical Computer Resources	AF-0136
	Derive Schedule	AF-0137
	Risk Identification	AF-0138
	Risk Analysis	AF-0139
	Risk Prioritization	AF-0140
	Manage Critical Paths	AF-0145
<b>IM.Ac6</b>	Estimate Size	AF-0133
	Manage Size	AF-0141
<b>IM.Ac7</b>	Estimate Effort	AF-0134
	Estimate Cost	AF-0135
	Manage Effort	AF-0142
	Manage Cost	AF-0143
<b>IM.Ac8</b>	Estimate Critical Computer Resources	AF-0136
	Manage Critical Computer Resources	AF-0144

<b>IM.Ac9</b>	Derive Schedule	AF-0137
	Manage Critical Paths	AF-0145
	Manage Schedule	AF-0169
<b>IM.Ac10</b>	Risk Identification	AF-0138
	Risk Analysis	AF-0139
	Risk Prioritization	AF-0140
	Develop Software Risk Management Plan	AF-0146
	Manage Risks	AF-0147
<b>IM.Ac11</b>	Event Driven Review	AF-0109
	Evaluate Process	AF-0070
	Project Review	AF-0148
	<b>Software Product Engineering</b>	
<b>PE.Ac1</b>	Develop PDSP	AF-0130
<b>PE.Ac2</b>	Review Allocated Requirements	AF-0149
	Correct Allocated Requirements	AF-0150
	Requirements Analysis	AF-0151
	Develop Software Requirements Document	AF-0152
<b>PE.Ac3</b>	Develop Design Criteria	AF-0153
	Develop Software Architecture Design	AF-0154
	Develop Software Detail Design	AF-0155
<b>PE.Ac4</b>	Develop Software Code	AF-0156
<b>PE.Ac5</b>	Plan Unit Tests	AF-0157
	Perform Unit Tests	AF-0158
<b>PE.Ac6</b>	Plan Integration Tests	AF-0159
	Perform Integration Tests	AF-0160
<b>PE.Ac7</b>	Plan System Tests	AF-0161
	Perform System Tests	AF-0162
<b>PE.Ac8</b>	Develop Software Documentation	AF-0163
	Maintain Software Documentation	AF-0164
<b>PE.Ac9</b>	Analyze Data	AF-0073
	Measure Product	AF-0118
<b>PE.Ac10</b>	Maintain Consistency	AF-0165
<b>PE.Me1</b>	Analyze Data	AF-0073
<b>PE.Me1</b>	Measure Product	AF-0118
	<b>InterGroup Coordination</b>	
<b>IC.Ac1</b>	Establish System Requirements	AF-0166
<b>IC.Ac2</b>	Track Technical Activities	AF-0117
	Coordinate Technical Activities	AF-0167
	Resolve InterGroup Issues	AF-0168
<b>IC.Ac3</b>	Communicate Supplier Requirements	AF-0095
	Project Planning	AF-0114
<b>IC.Ac4</b>	Determine Key Supplier Requirements	AF-0096
	Project Planning	AF-0114
	Manage Critical Paths	AF-0145
	Manage Schedule	AF-0169

IC.Ac5	Review Product	AF-0108
IC.Ac6	Resolve InterGroup Issues	AF-0168
IC.Ac7	Activity Review	AF-0120
	<b>Peer Reviews</b>	
PR.Ac1	Plan Peer Review	AF-0170
PR.Ac2	Review Product	AF-0108
PR.Ac3	Review Product	AF-0108
	<b>Quantitative Process Management</b>	
QP.Ac1	Project Planning	AF-0114
	Set Performance Objectives	AF-0074
QP.Ac2	Set Performance Objectives	AF-0074
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Analyze PDSP	AF-0172
	Communicate Information	AF-0097
	Maintain Process Capability Baseline	AF-0173
QP.Ac3	Determine Indicators	AF-0071
	Develop Measurement Analysis Strategy	AF-0171
QP.Ac4	Determine Indicators	AF-0071
	Set Performance Objectives	AF-0074
	Measure Process	AF-0072
	Analyze Data	AF-0073
QP.Ac5	Analyze PDSP	AF-0172
QP.Ac6	Communicate Information	AF-0097
QP.Ac7	Maintain Process Capability Baseline	AF-0173
	<b>Software Quality Management</b>	
SQ.Ac1	Project Planning	AF-0114
SQ.Ac2	Analyze Data	AF-0073
	Measure Product	AF-0118
SQ.Ac3	Set Performance Objectives	AF-0074
	Manage Quality	AF-0174
SQ.Ac4	Analyze Data	AF-0073
	Measure Product	AF-0118
	Manage Quality	AF-0174
SQ.Ac5	Allocate Quality Goals	AF-0175
	<b>Defect Prevention</b>	
DP.Ac1	Project Planning	AF-0114
DP.Ac2	Conduct Task Preparation Meeting	AF-0176
DP.Ac3	Determine Root Cause	AF-0043
DP.Ac4	Coordinate Prevention Action	AF-0177
DP.Ac5	Analyze Data	AF-0073
	Measure Product	AF-0118
	Determine Root Cause	AF-0043
DP.Ac6	Coordinate Prevention Action	AF-0177
	Maintain OSSP	AF-0192

DP.Ac7	Revise PDSP	AF-0131
DP.Ac8	Communicate Information	AF-0097
	<b>Technology Change Management</b>	
TC.Ac1	Strategic Planning	AF-0075
TC.Ac2	Identify Technology Change Areas	AF-0178
TC.Ac3	Communicate Information	AF-0097
TC.Ac4	Analyze OSSP	AF-0179
TC.Ac5	Select Technology	AF-0180
	Acquire Technology	AF-0181
TC.Ac6	Conduct Technology Pilot	AF-0182
TC.Ac7	Analyze OSSP	AF-0179
	Maintain OSSP	AF-0192
TC.Ac8	Revise PDSP	AF-0131
	<b>Process Change Management</b>	
PC.Ac1	Maintain Improvement Program	AF-0040
PC.Ac2	Set Goals	AF-0019
	Coordinate Process Improvement Activities	AF-0183
	Review Process Improvement Proposal	AF-0184
PC.Ac3	Strategic Planning	AF-0075
PC.Ac4	Set Goals	AF-0019
	Coordinate Process Improvement Activities	AF-0183
	Review Process Improvement Proposal	AF-0184
	Develop Action Plan	AF-0185
	Communicate Information	AF-0097
	Pilot Process Improvement	AF-0186
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Implement Process	AF-0187
	Maintain SPI Activity Records	AF-0188
PC.Ac5	Review Process Improvement Proposal	AF-0184
PC.Ac6	Develop Action Plan	AF-0185
PC.Ac7	Pilot Process Improvement	AF-0186
PC.Ac8	Measure Process	AF-0072
	Analyze Data	AF-0073
	Implement Process	AF-0187
PC.Ac9	Maintain SPI Activity Records	AF-0188
PC.Ac10	Communicate Information	AF-0097
PC.Me	Measure Process	AF-0072
PC.Me	Analyze Data	AF-0073

## *Appendix E - Quality Air Force Criteria Map to Integrated Requirements*

### *1.0 Purpose*

The overall purpose of this document is to reference the Quality Air Force (QAF) criteria to the integrated requirements.

### *2.0 Overview*

This document maps the QAF to the integrated requirements. All QAF areas and items are included. The document is organized to mirror the categories, areas to address, and items in the QAF criteria.

### *3.0 Guide to Codes*

#### 1.0 Leadership

- 1.1 Senior Executive Leadership
- 1.2 Leadership System and Organization
- 1.3 Public Responsibility and Citizenship

#### 2.0 Information and Analysis

- 2.1 Management of Information and Data
- 2.2 Comparisons and Benchmarking
- 2.3 Analysis and Use of Organization-Level Data

#### 3.0 Strategic Planning

- 3.1 Strategy Development
- 3.2 Strategic Deployment

#### 4.0 Human Resource Development and Management

- 4.1 Human Resource Planning and Evaluation
- 4.2 High Performance Work Systems
- 4.3 Member Education, Training, and Development
- 4.4 Well Being and Satisfaction

## 5.0 Process Management

### 5.1 Design and Introduction of Products and Services

### 5.2 Key Process Management: Product and Service Production and Delivery

### 5.3 Process Management: Support Services

### 5.4 Supplier Performance Management

## 6.0 Performance Results

### 6.1 Product and Service Quality

### 6.2 Operational Performance and Financial Results

### 6.3 Supplier Performance Results

## 7.0 Customer Focus and Customer Satisfaction

### 7.1 Customer Knowledge

### 7.2 Customer Management

### 7.3 Customer Satisfaction Determination

### 7.4 Customer Satisfaction Results

### 7.5 Customer Satisfaction Comparison

Area	Name	ID
	<b>Leadership</b>	
<b>1.1.a</b>	Develop Organizational Values	AF-0001
	Set Directions	AF-0002
	Set Expectations	AF-0003
	Build Organizational Capabilities	AF-0011
	Set Goals	AF-0019
	Recognize Member	AF-0027
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Reinforce Organizational Values	AF-0078
	Process Assessment	AF-0080
<b>1.1.b</b>	Review Organizational Structure	AF-0005
	Improve Leadership System	AF-0012
	Improve Organization Structure	AF-0013
	Evaluate Process	AF-0070
<b>1.2.b</b>	Communicate Leadership Information	AF-0079
<b>1.2.c</b>	Review Organizational Performance	AF-0004
	Process Assessment	AF-0080
	Event Driven Review	AF-0109
	Project Review	AF-0148
<b>1.3.a</b>	Set Citizenship Goals	AF-0081
	Assess Community Impact	AF-0082
	Improve Community Involvement	AF-0021
	Plan Community Involvement	AF-0083
	<b>Information &amp; Analysis</b>	
<b>2.1.a</b>	Determine Customer Data Requirements	AF-0006
	Determine Indicators	AF-0071
<b>2.1.b</b>	Evaluate Process	AF-0070
<b>2.2.a</b>	Determine Benchmarking Requirements	AF-0007
	Set Benchmarking Priorities	AF-0008
	Determine Benchmarking Data Criteria	AF-0009
	Develop Breakthrough Approach	AF-0022
	Determine Indicators	AF-0071
	Analyze Data	AF-0073
	Set Performance Objectives	AF-0074
	Gather External Data	AF-0084
	Identify Technology Change Areas	AF-0178
	Implement Process	AF-0187
<b>2.2.b</b>	Evaluate Process	AF-0070
<b>2.3.a</b>	Aggregate Data	AF-0010
	Analyze Data	AF-0073
	Gather Internal Data	AF-0098

	<b>Strategic Planning</b>	
<b>3.1.a</b>	Strategic Planning	AF-0075
<b>3.1.b</b>	Set Objectives	AF-0014
	Determine Key Performance Drivers	AF-0015
	Determine Partnering Activities	AF-0085
<b>3.1.c</b>	Evaluate Process	AF-0070
<b>3.2.a</b>	Align Plans	AF-0086
	Develop Action Plan	AF-0185
<b>3.2.b</b>	Project Key Indicator Data	AF-0016
	Determine Benefits	AF-0017
	Analyze Data	AF-0073
	<b>Human Resource Development and Management</b>	
<b>4.1.a</b>	Strategic Planning	AF-0075
<b>4.1.b</b>	Assess Member Well-Being	AF-0023
	Assess Member Development	AF-0024
	Evaluate Process	AF-0070
	Align Plans	AF-0086
	Assess Workforce Satisfaction	AF-0090
	Assess Workforce Motivation	AF-0091
<b>4.2.a</b>	Improve Work Organization	AF-0025
	Improve Job Design	AF-0026
	Evaluate Job Design	AF-0076
	Evaluate Work Organization	AF-0077
<b>4.2.b</b>	Recognize Member	AF-0027
	Compensate Member	AF-0028
	Evaluate Member	AF-0029
<b>4.3.b</b>	Evaluate Training	AF-0018
	Assess Member Development	AF-0024
	Improve Training	AF-0030
	Evaluate Job Design	AF-0076
	Reinforce Training	AF-0087
	Plan Training Delivery	AF-0088
	Identify Training Needs	AF-0089
	Perform Training	AF-0124
	Develop Training Course	AF-0125
	Measure Training Quality	AF-0128
	Independent Training Evaluation	AF-0129
	Develop Design Criteria	AF-0153
<b>4.4.a</b>	Review Work Environment	AF-0031
	Improve Work Environment	AF-0032

<b>4.4.b</b>	Build Workforce Well-Being	AF-0033
	Build Workforce Satisfaction	AF-0034
	Assess Member Services	AF-0035
	Assess Member Facilities	AF-0036
	Assess Member Activities	AF-0037
<b>4.4.c</b>	Assess Member Well-Being	AF-0023
	Assess Workforce Satisfaction	AF-0090
	Assess Workforce Motivation	AF-0091
	<b>Process Management</b>	
<b>5.1.a</b>	Design Process	AF-0038
	Design Service	AF-0039
	Implement Process	AF-0040
	Project Planning	AF-0114
	Develop Design Criteria	AF-0153
	Develop Software Architecture Design	AF-0154
	Develop Software Detail Design	AF-0155
<b>5.1.b</b>	Test Product	AF-0041
	Test Service	AF-0042
	Review Product	AF-0108
	Pilot Process Improvement	AF-0186
<b>5.1.c</b>	Evaluate Process	AF-0070
	Evaluate Product	AF-0092
	Evaluate Service	AF-0093
<b>5.2.a</b>	Measure Process	AF-0072
	Determine Root Cause	AF-0043
	Analyze Data	AF-0073
	Project Planning	AF-0114
	Take Corrective Actions	AF-0116
<b>5.2.b</b>	Evaluate Alternatives	AF-0044
	Evaluate Process	AF-0070
	Do Research	AF-0094
	Implement Process	AF-0187
<b>5.3.a</b>	Develop Design Criteria	AF-0153
<b>5.3.b</b>	Determine Root Cause	AF-0043
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Project Planning	AF-0114
	Take Corrective Actions	AF-0116
	Implement Process	AF-0187
<b>5.3.c</b>	Evaluate Alternatives	AF-0044
	Evaluate Process	AF-0070
	Do Research	AF-0094

5.4.a	Determine Indicators	AF-0071
	Measure Process	AF-0072
	Analyze Data	AF-0073
	Communicate Supplier Requirements	AF-0095
	Determine Key Supplier Requirements	AF-0096
	Communicate Information	AF-0097
	Measure Product	AF-0118
	Project Review	AF-0148
5.4.b	Build Supplier Relationship	AF-0045
	Evaluate Process	AF-0070
	Change Supplier Commitment	AF-0113
	Plan Supplier Work	AF-0119
	Implement Process	AF-0187
	<b>Performance Results</b>	
6.1.a	Analyze Data	AF-0073
	Gather Internal Data	AF-0098
	Measure Product	AF-0118
6.2.a	Measure Process	AF-0072
	Analyze Data	AF-0073
	Gather Internal Data	AF-0098
6.3.a	Measure Process	AF-0072
	Analyze Data	AF-0073
	Measure Product	AF-0118
	<b>Customer Focus and Customer Satisfaction</b>	
7.1.a	Determine Customer Requirements	AF-0046
	Determine Customer Expectations	AF-0047
	Determine Indicators	AF-0071
	Determine Customer Groups	AF-0099
	Select Group	AF-0100
	Gather Customer Information	AF-0101
7.1.b	Determine Future Customer Requirements	AF-0048
	Determine Future Customer Expectations	AF-0049
	Develop Listening Strategies	AF-0050
7.1.c	Evaluate Process	AF-0070
7.2.a	Communicate Information	AF-0097
	Provide Customer Access	AF-0102
	Maintain Service Standards	AF-0103
	Maintain Product Standards	AF-0104
	Gather Customer Feedback Data	AF-0105
7.2.b	Analyze Data	AF-0073
	Gather Customer Information	AF-0101
	Record Customer Complaint	AF-0106
	Evaluate Customer Complaint	AF-0107

<b>7.2.c</b>	Evaluate Mission Effectiveness	AF-0051
	Analyze Data	AF-0073
<b>7.2.d</b>	Evaluate Process	AF-0070
<b>7.3.a</b>	Evaluate Mission Effectiveness	AF-0051
	Analyze Data	AF-0073
	Determine Customer Groups	AF-0099
<b>7.3.c</b>	Evaluate Measurement Scale	AF-0052
	Improve Measurement Scale	AF-0053
	Evaluate Process	AF-0070
<b>7.4.b</b>	Analyze Data	AF-0073
<b>7.5.a</b>	Analyze Data	AF-0073
<b>7.5.b</b>	Analyze Data	AF-0073

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13. ABSTRACT (Maximum 200 words) As defense budgets decrease and it is required to do more with less, the Air Force has chosen to use the Malcolm Baldrige National Quality Award (MBNQA) as the basis for implementing quality principles. The Air Force program is known as Quality Air Force (QAF), and the criteria are referred to as the QAF criteria [DEPA95b]. At about the same time the Department of the Air Force implemented QAF, the software leaders in the Air Force adopted the Capability Maturity Model for Software (CMM) as the internal standard for Air Force software organizations [MOSE91]. Software organizations strapped with both sets of requirements struggle with how to implement both models. Many organizations implement redundant programs in an effort to satisfy both. This research uses signature and specification matching techniques gleaned from the software reuse domain to integrate the CMM and QAF criteria into a single set of requirements that correlate to both models.				
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